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EDITOR'S OUTLOOK

THE subject of this month's frontispiece is known to fame chiefly for his success in working out a process which made possible the synthesis of ammonia on a commercial scale and which thus revolutionized industry and agriculture. Fritz Haber, who received the Nobel award of 1918 for this contribution to chemistry, is not, however, a man whose legacy to posterity consists of this service alone, signal though it is. Of wide intellectual and social interests, Haber has been unable to confine his versatile powers and has in fact cultivated them to an unusual degree and with far-reaching results even within the bounds of specialization.

Fritz Haber, 1868–

Haber was born in Breslau on December 9, 1868. His early training at the humanistic gymnasium of St. Elizabeth aroused in him a deep interest in philosophy and literature as well as science, but it was to chemistry that he decisively turned in his eighteenth year in the choice of a career. A semester at Berlin under Helmholtz and Hoffman proved unsatisfactory; for the meticulous analytical procedures of Bunsen's laboratory at Heidelberg he had neither taste nor patience; and after a brief interlude of commercial work, and of study with Ludwig Knorr, we find the wandering young scholar contentedly settling down in 1894 at Karlsruhe where he found opportunity so much more to his liking that he spent there the ensuing seventeen years. These brought him into association with Bunte and Engler, and although Haber has always held these great teachers in affectionate regard, it would seem that his development was not greatly influenced at any time by professors or directors but was impelled rather by powers within himself which were irresistibly drawn to the problems presented to his creative intelligence.

His first appointment at Karlsruhe as Bunte's assistant left him a great deal of freedom, which he utilized in working out privately his early studies in electrochemistry. He taught gas-chemistry, as well as that of dyes and textiles, at the Technische Hochschule and lectured of his own choice to a few special students who shared his enthusiasm for electrochemistry. His researches throughout the Karlsruhe period covered the theory of the pyrogenic reaction of aliphatic compounds, the combustion of illuminating gas, the water-gas equilibrium in the Bunsen flame, the decomposition of gases in a very hot flame, and the constitution of the inner cone of the Bunsen flame. To organic chemistry he contributed an explanation of the reduction of nitro-compounds; to inorganic, the preparation of pure carbon from carbonates during electrolysis; to textile chemistry, a new process of color printing.

It was in the latter half of the Karlsruhe period that Haber interested himself in the reactions of nitrogen and, in collaboration with Le Rossignol, after many disappointments, succeeded in 1908 in constructing an apparatus, which by the use of high temperature and pressure, and the

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selection of osmium and uranium as catalysts, achieved the first direct synthesis of ammonia. At the advice of Engler, the Badische Anilin Soda Fabrik became interested in the process and sent its representatives to look over the apparatus which was turning out 100 cc. liquid ammonia per hour. The history of failures among the investigators who had been working at the problem for years had produced an attitude of scepticism toward it, and when the company's representatives arrived, the little model refused to work. Mittasch, however, remained in patience and when the apparatus was restored to operation, he must have visualized beyond it the great system of nitrogen fixation plants of which it was the beginning. The company took over the process, it passed from the laboratory to the factory, and the two huge plants which arose speedily at Oppau and Merseburg became the nucleus of an industry that formed immediately a very great factor in the economic life of Germany.

During the World War Haber served on Germany's war-ministry as a member of the group of scientists who endeavored to conserve and use to best advantage the raw materials with which the country was so ill supplied. His knowledge of gas-chemistry gave the German army the method of projection which was used in the first gas-attack at Ypres and he it was who organized and directed thereafter the development of knowledge in gas offense and defense and the instruction of the military organization in their use.

His war service over, Haber returned to face discouragement and difficulty in the way of readjustment to his normal scientific pursuits. He had established in 1911 the Kaiser-Wilhelm Institute for Physical and Electro-chemistry at Dahlem, in which, from its beginning, important researches were carried on under a system which permitted every possible freedom to the individual worker, while the investigations developed in coördination under a director beyond whose vision or experience it would have been difficult for his subordinates to expand. The financial resources of this institute, however, were withdrawn during the war. The 1918 Nobel award to Haber partly smoothed his way, and gradually but surely he drew together again a staff of physicists and physical and colloid chemists of distinction. He continues still in the direction of the institute, his latest interests being in the field of biological and agricultural chemistry.

Willstätter, a friend of Haber, has outlined the qualities of the man in a few telling strokes: "breadth of vision, depth of thought and perception, love of new and often unconquerable kingdoms of thought, wealth of ideas and of verbal expression, warmth of feeling." "His greatness," he says, "lay in the conception of ideas of a scientific nature. The stimulation, the plan, the method were to him more important than the result. Creative work pleased him more than the completed task."

As an illustration of this, we may cite the story, told by Willstätter, of Haber's experiments to determine the gold content in sea-water and to work out a method of extraction. Search of the north and south Atlantic and of the Polar seas revealed at best a pitifully small proportion of the metal, but when Haber was asked about his attitude as to the results, he replied, "If there was no gold, there will at least be a fine book." Haber began as a youth to seek "for the causes of things"; with friends and associates, in art and in science, in the history of the past and of the present, in national and international concerns, his search has continued, and has made his life an intellectual adventure whose zest has never failed.

The American University

THE American University has come in for its full share of the "debunking" which has been applied of late years to American institutions in general and American education in particular. A great deal of the resultant criticism has been superficial—amusing or exasperating according to one's temperament and affiliations. Some of it has been truly analytical and has shown a reasonable regard for what can be as well as for what would be desirable if possible. Some of the critics and pseudo-critics leave one with the impression that their wails proceed from the same cause as those of a distressed infant. They are unhappy; they don't quite know why, and they have no very clear idea what can be done about it; but somebody should do something. Others have in mind more or less definite ideals of what a university should be and more or less definite ideas about the respects in which the American University falls short of those ideals. Sometimes they lay their ideals before their readers; sometimes one has to divine them for himself.

A surprisingly large number of criticisms (and among these we find one of the most recent, most entertainingly written and most devastating commentaries) proceed from the thesis that the American University should be essentially a duplicate of the best of the European universities. Or perhaps it would be more accurate to say of the mental picture of a first-rate European university which the critic has evolved. The question which we desire to raise at this point is whether or no that thesis is defensible.

Is there, in fact, such a thing as an ideal university which might be set up anywhere, with only minor modifications in concession to its political, sociological, and economic environment? Or should the university be a natural outgrowth of the society and the philosophy in which it springs up? It is necessary to answer these questions in our own minds before we can evaluate some of the criticisms which are leveled against the American University. For many of the most frequently and loudly de-

nounced characteristics of the American University are precisely those characteristics which stamp it indelibly as a consistent portion of the American scene.

We are told that the American University in general is not sufficiently exclusive—that it admits entirely too many students who are incapable, both by reason of temperament and of mental equipment, of benefiting by education on a university level. We are told that it devotes a major portion of its resources and energies to education on a secondary level. We are told that too much of its work is vocational rather than scholarly—that, for the most part, it trains rather than educates. If these things were not so, it might be a more dignified and in every way more admirable institution, but it would not be American.

Consider for a moment a few of the fundamental tenets of our American creed. In the first place we are irrevocably committed to the principle that one man is as good as another. No one is expected to believe it; in fact, not even the inferior man actually does believe it. But we do demand that public institutions and individuals in positions of public trust shall abide by the fiction. In the educational field we are forced to rationalize this myth to a certain extent. We say it means that all men are by right entitled to equal opportunities. Some of us hedge a little more and say that every man is entitled to all the opportunities of which he can make good use. Obviously, this latter qualification is susceptible of more than one interpretation. It may, but seldom does, mean that a student incapable of benefiting by university instruction has no right to enter a university. On the other hand it may, and often does, mean that, if the university as constituted has nothing to offer a certain grade of student, it ought to add to its stock in trade.

It is thus a natural consequence of our political and social philosophy that the university should be regarded by the majority of our people, not as an independent institution with ideals and objectives of its own, but as a servant of the people. In this point of view the state universities perforce concur unanimously, and to it practically all of our privately endowed universities make substantial concessions. So much for the matter of entrance requirements and for the secondary level at which a great deal of the work of the American University is done.

What we have already said has its bearing upon the vocational aspects of American University "education." Our national economic structure is such that great numbers of students who feel themselves entitled to such distinction as a university degree may confer and who can pay the bills and pass the examinations must look forward to earning a living eventually. They and their parents feel that they must combine vocational training with education.

But there is another influence at work also. It is the American veneration of industry, *per se*. In order to maintain an appearance of respecta-

bility every American must spend the best years of his life in working at something, no matter how inconsequential, whether he needs the money or not. It is nobler by far to sell stocks to suckers, or to yawn through board meetings, than to engage in the pursuits of a scholar and a gentleman. In short, we have no leisure class in the better sense of the term. Wasters and idlers we have, and retired captains of industry who have "earned the right to a rest," but other than these, nothing. We have patrons of the arts and sciences, but very few economically independent amateur practitioners of them.

The conclusion of the matter is that American life is vocational and that the American University to some extent takes its color from American life. In America there is little demand for truly scholarly education except among prospective professors, and the demand is by no means unanimous among them. The American University adapts itself to the demands of its customers.

To argue that other agencies should have been set up to meet these demands and that the universities should have held aloof is, we believe, to attach a disproportionate importance to the names of things. No one argues that it is impossible to obtain a true university education in America, any more than any one argues that it is impossible to have a prescription filled at an American drug store. The chief criticism is that both the American drug store and the American University dispense so many gadgets and gim-cracks that the functions which are suggested by their names are entirely overshadowed.

We suggest that many of the critics who deplore the status of the American University are either over-impressed by names or over-preoccupied with symptoms. The American University is one of the inevitable symptoms of American life. If that is fundamentally deranged, little can be accomplished by administering nostrums to the universities.

Contemporary News

THE replies to a recent questionnaire indicate that only about one-third of the readers of the JOURNAL OF CHEMICAL EDUCATION have been interested in the former *Local Activities* section. A number of readers made the remark that in their opinion the space so employed could be put to better use. In consideration of these facts, but with due respect for the desires of readers who are interested in current events in chemistry and education, we are substituting for the *Local Activities* a section devoted to *Contemporary News in Chemistry and Education*. The department will differ from the old chiefly in that items of purely local interest will be omitted. Which is to say that the paragraphs which formerly prefaced the *Local Activities* will be less liberally interpreted and more strictly adhered to.

THE DIALYZER

(*For questions* 1–3 *see* pages 7–29.)

1. Describe the process by which the naturally occurring rubber hydrocarbon is purified.
2. Describe briefly the physical structure of rubber.
3. What is the reaction between sulfur and rubber during the process of vulcanization?
4. What opportunities for women in chemistry exist in Spain? (pp. 30–4.)
5. What were the chief pigments used in the pottery of the inhabitants of prehistoric America? Distinguish chemically between two of the common black ones. (pp. 35–42.)
6. Who was Pierre Auguste Adet? What part did he play in the phlogiston controversy? (pp. 43–8.)

(*For questions* 7–9 *see* pp. 55–62.)

7. Compare water and ammonia with respect to solvent power.
8. If the water in our world were replaced by ammonia, would there be any icebergs?
9. What type of life could exist in an ammonia world?

(*For questions* 10–13 *see* pp. 63–106.)

10. Are the salaries of chemistry teachers in the United States commensurate with the training required of them?
11. Discuss four major present-day problems confronting the directors of teacher training in this country? How should our educational programs be modified to meet these?
12. Compare qualifications of chemistry teachers in secondary schools with those of chemistry teachers in colleges.
13. What are the advantages from the point of view of teacher training of the present university system of employing graduate student-teachers? Disadvantages?

(*For questions* 14–15 *see* pp. 107–14.)

14. What proportion of a first-year course in organic chemistry should be devoted to practical work?
15. What details of preparation would it be necessary to give students in order that they could prepare caffeine from tea?
16. During the school year 1929–30 how was the teaching load distributed among chemistry teachers of the United States? (pp. 115–27.)
17. What slides are available for use in chemistry classes? (pp. 128–32.)
18. Are rubber bricks practical for paving? (p. 132.)
19. Is there any uniform policy used by colleges and universities in assigning chemistry laboratory fees and deposits? (pp. 133–9.)

(*For questions* 20–1 *see* pp. 143–8.)

20. What substances may be found in a representative sample of pig iron?
21. Of three iron ores, hematite, limonite, and magnetite, which would be most valuable for pig iron manufacture if each contained the same percentage of iron compound?
22. How might an assignment on molecular weights be outlined in order to utilize the student's originality? (pp. 152–9.)

(*For questions* 23–5 *see* pp. 180–97.)

23. What meeting was recently held in the home town of Charles M. Hall, the discoverer of aluminum?
24. Who are the Nobel prize winners in physics and in chemistry for the year 1930? For what achievements were these awards given?
25. What fellowships and scholarships for study in foreign countries are open to American students?

RUBBER: NEWER THEORETICAL AND PRACTICAL DEVELOPMENTS*

HARRY L. FISHER, UNITED STATES RUBBER COMPANY, PASSAIC, NEW JERSEY

The yield of plantation rubber is being increased from 350 to 1000 pounds per acre by means of bud-grafting. Latex can be vulcanized. The importance has been shown of some of the non-rubber constituents in the manufacture of rubber goods. The highly purified rubber hydrocarbon has been separated into rather indistinct components, and has been crystallized and even distilled. The chemical structure of natural and of synthetic rubber, and of the newer chemical derivatives, is discussed. X-ray studies show a definite alignment of fibers when rubber is stretched, and the fibrous nature of stretched rubber has been proved experimentally at low temperatures. Vulcanization, aging, and the newer applications of rubber in lining chemical apparatus for preventing ice formation on airplanes, in upholstery, rugs, etc., are summarized.

. . . . . .

A glance at the subject of rubber in the two decennial indexes and the last three annual indexes of *Chemical Abstracts* reveals the following interesting facts:

Articles on Rubber Published during Last Twenty Years

Index	*No. of columns*	*Av. no. of Columns per Annum*
Decennial, 1907–16	19.25	1.9
Decennial, 1917–26	30.1	3.0
Annual, 1927	6.75	
Annual, 1928	8.5	8.45
Annual, 1929	10.1	

This table shows the great increase in the number of articles published on rubber today as compared with the number published ten and twenty years ago. Every one is, of course, familiar with the wonderful growth of the rubber industry, and it is worth noting that the technical literature has kept pace with this growth. The rubber goods manufactured in this country today are valued at around a billion dollars, and a moment's reflection will convince any one of the necessity of these goods for satisfying many of life's multitudinous daily requirements.

It was a matter of good fortune that the rubber plantations were beginning to bear when automobiles were being manufactured in quantity because the amount of rubber produced in the Amazon Valley and in Africa could not have taken care of the growing needs of this important industry. In 1910 the plantations produced only 11,000 tons of crude rubber but last year they produced 826,000 tons; and in the same years Brazil and the rest of the tropical world produced 83,000 and 28,000 tons,

* Presented before the Rhode Island Section of the A. C. S., at Brown University, October 16, 1930.

FIGURE 1.—BUD SPROUT TWO MONTHS OLD

respectively. The full meaning of these figures becomes apparent when it is realized that the manufacture of tires and tubes last year required almost 700,000 tons or about eighty per cent of the total crude rubber produced.

Scientific development work on the plantations has had much to do with their phenomenal growth, and one of the newest and most interesting of these developments is that of bud-grafting (*1*). There is considerable variation in the yield of rubber from individual trees and at present no method is available for predicting the future yielding capacity of a seedling. However, good yielding trees remain good yielders and poor yielders remain poor yielders. It happens that a bud reproduces the characteristics of a mother plant, and when a bud from a high-yielding tree is grafted to a one-year-old seedling in the nursery and subsequently transplanted to the field, the new tree usually is a high yielder. This method is not yet practiced generally but where it has been practiced the yield of crude rubber has been increased from about 350 lb. to 1000 lb. per acre. Figure 1 illustrates a bud sprout two months old.

Latex

Rubber is obtained from the milky exudation of trees, shrubs, and vines, belonging to several large botanical families which grow chiefly in the tropical zone. The most important family is the *Euphorbiaceae* and its chief genus is the *Hevea brasiliensis*, practically all the rubber of commerce being obtained from this famous rubber tree. The milky exudation or latex is contained in microscopic tubes in the cortex layer

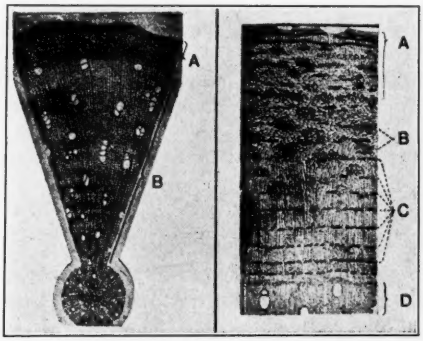


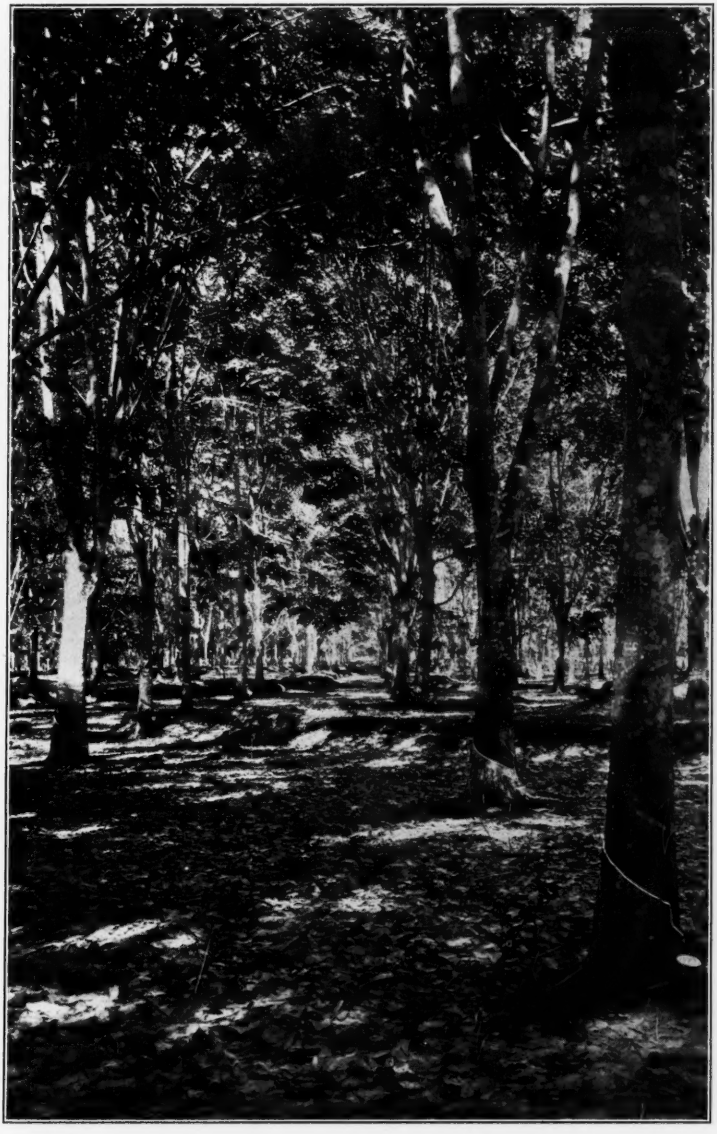
FIGURE 2

Transverse Section of Stem

A. Cortex and latex-bearing tissue
B. Wood tissue

Transverse Section of Cortex

A. Outer bark
B. Groups of stone cells occurring throughout the cortex
C. Rows of latex vessels
D. Wood tissue which is separated from the cortex by the cambium.



Grove of Mature Rubber Trees on One of the U. S. Rubber Company's Plantations

between the bark and the cambium (Figure 2). The latex is not the sap and in fact is quite different from it. The sap travels up and down the tree in the cambium layer, a very thin layer separating the cortex from the wood tissue. About two-thirds of the latex is water and the remaining one-third is a mixture of solid materials of which about eighty-five per cent is the rubber hydrocarbon.

The rubber hydrocarbon mixed with or surrounded by some of the insoluble non-rubber constituents exists in the latex as minute particles suspended in the watery solution. Some of the particles are visible under a good microscope, some only under an ultra-microscope, and some are not visible at all. Those microscopically visible vary from 0.5 to 3μ (0.0005–0.003 mm.) in diameter, and exhibit the usual Brownian movement. Each particle carries a negative electric charge. It is probable that each particle is made up of many much finer particles and that the size and shape depends on the number and the manner in which these finer or ultimate particles have combined. Von Weimarn (*2*), whose photographs illustrate this paragraph (Figure 3), describes latex as a polydisperse system of iso-aggregate particles with a general liquid-jelly consistency. The description given above is a free translation of his explanation.

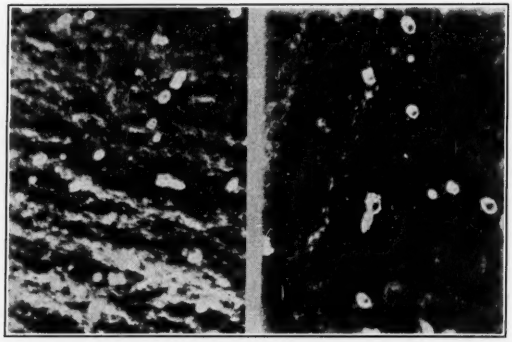


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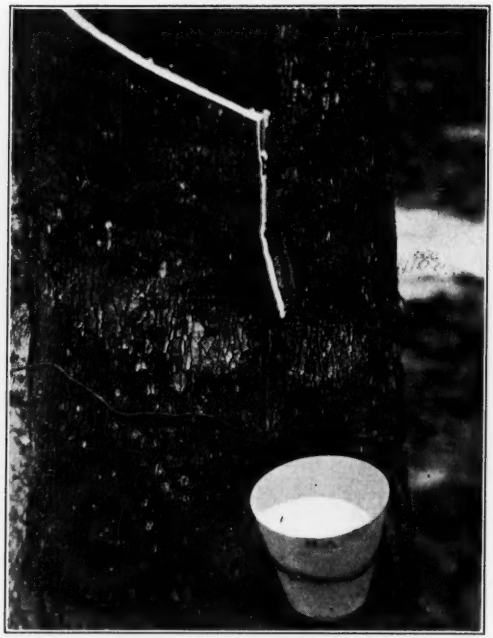
FIGURE 3.—LATEX PARTICLES

When an acid is added to latex, the particles, as seen under the microscope, cease their Brownian movement, coalesce and form strings or clots. To the naked eye, the latex becomes a semi-solid mass; the result of coagulation. On the plantations dilute acetic or formic acids are generally used. The coagulum is white and resembles a soft cheese. When squeezed much of the water is forced out and there remains a very tough coherent mass. The coagulum, squeezed between two iron rollers, each one driven at a different speed, and washed at the same time with running water, forms the pale crêpe of commerce. When squeezed between even-speed rollers and dried in a smoke house, it becomes smoked sheet. The latex without being coagulated can be spray-dried in a chamber filled with warm air, and there is thus formed a very homogeneous crude rubber,

TAPPING



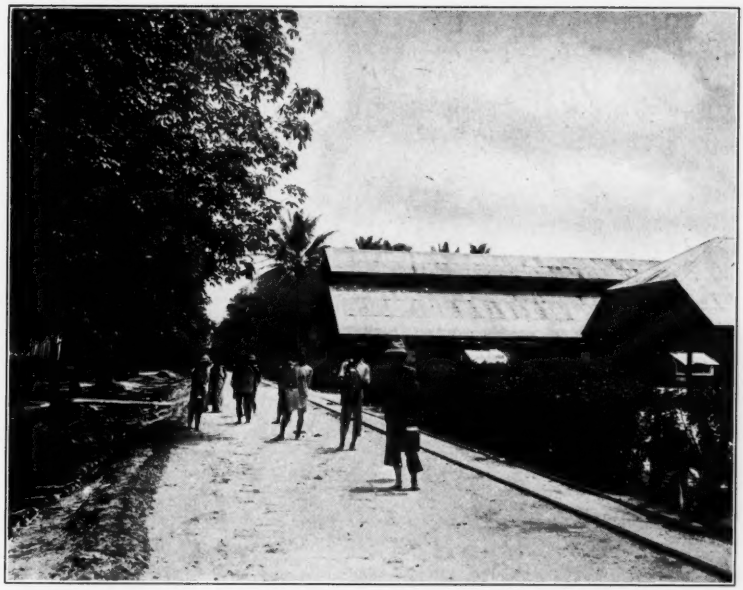
LATEX FLOWING FROM TAPPING CUT IN BARK AND DRIPPING INTO CUP

known as L. S. rubber, containing all the latex solids.

Fresh latex is approximately neutral, its pH being 7.0–7.2. It coagulates a short time after tapping because of the presence of acids formed by bacterial action on the non-rubber constituents. Latex can be preserved by the addition of ammonia, formaldehyde, etc., and at the present time, preserved with ammonia, it is shipped in tank steamers from the plantations to this country, where it is finding considerable use in the new developments of rubber manufacture.

Preserved latex "creams" on standing, just as milk does, but the cream from latex contains chiefly the rubber hydrocarbon, whereas that from milk contains chiefly globules of fat. Creaming can also be carried out by the addition of certain hydrophilic agents, such as Irish moss, gelatin, ammonium alginate (*3*). It is possible by successive treatments to concentrate creams to about seventy-five per cent of the rubber hydrocarbon, and at the same time remove most of the soluble non-rubber constituents. Such concentrated creams have the consistency of butter but can of course be diluted to any extent by the addition of water (*4*).

Crude rubber can be redispersed to form an artificial latex (*5*). This is done by mixing into it, in a partially enclosed mill similar to a Werner-Pfeiderer mixer, a hydrophilic colloid, such as glue, soaps, and certain clays, and then slowly adding water. At first the water mixes into the batch just as the other ingredients mix in, but later the mixture reverts and then the rubber which in the beginning was in the outer phase is now in the inner phase. The water-in-oil type of mixture inverts to an oil-in-water type. Artificial latexes have properties very similar to those



ON THE WAY TO A COLLECTING SHED WITH PAILS FULL OF LATEX

COLLECTING STATION

All tapping coolies in the division bring their latex daily to the collecting station where it is weighed and emptied into the storage tank up the stairs. Ammonia to the amount of one-quarter of one per cent is added to the contents of the tank as a preservative. The small tanks on the ground at the right contain pure aqueous ammonia. Directly underneath the storage tank in the shed is one of the narrow-gage tank cars.

of natural latex and are being used in several commercial applications.

Although acid coagulates latex, it is possible to make the latex acid (*6*) without coagulating it by adding certain protective agents; for example, the sodium salt of the reaction product obtained by condensing naphthalene and isopropyl alcohol in the presence of sulfuric acid. An acid latex thus prepared will remain stable indefinitely.

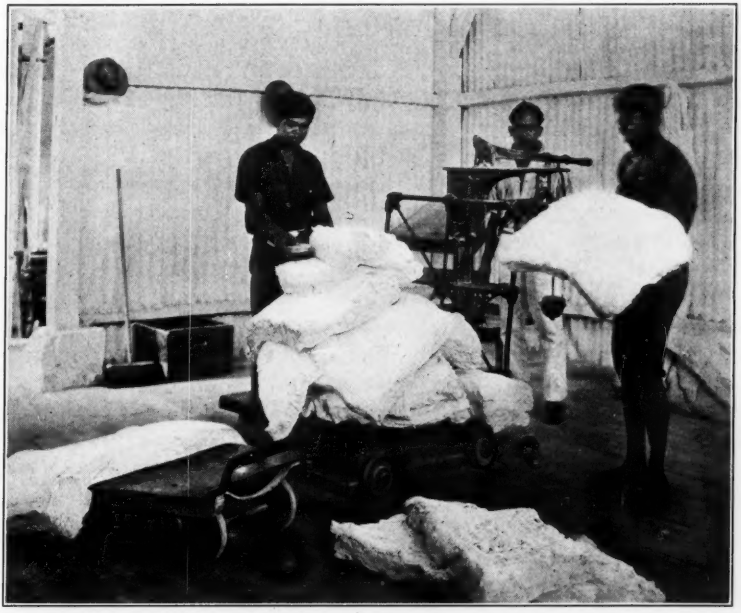
Latex can be vulcanized by heating it with alkali polysulfides (*7*). On coagulation or direct drying, it gives a product which has most of the characteristics of a typical vulcanized rubber.

The Non-Rubber Constituents

In a thirty-three per cent latex about one-sixth of the total solids, or five per cent of the latex, consists of the so-called non-rubber constituents, and about nine-tenths of these by weight remain with the rubber hydrocarbon after the coagulation, washing, and drying. Although crude rubber owes its chief properties to the presence of the rubber hydrocarbon, nevertheless, the non-rubber constituents play important parts in the manufacture and the properties of rubber goods. For example, the proteins and their decomposition products act as accelerators of vulcanization and aid in toughening the vulcanized rubber (*8*); the fatty acids react with such important compounding ingredients as the oxides of zinc, lead, and magnesium, and form salts which are soluble in the rubber and have much to do with the action of accelerators (*9*); and the liquid sterols present are powerful antioxidants and are chiefly responsible for the preservation of crude rubber (*10*). Acetone is generally used to extract most of the non-rubber constituents, and this procedure is an important part of rubber analysis. The materials extracted with acetone are called "resins," and the amount is two and one-half to three per cent of the crude rubber. The fatty acids present are chiefly oleic and linoleic and a small amount of stearic (*9*). Other organic substances besides those mentioned above are quebrachitol, which is a methyl ether of inositol (a cyclic sugar), a phytosterol, a phytosterol glucoside, a sterol ester of a fatty acid, *d*-valine, *n*-octadecyl alcohol, a ketone, $C_{15}H_{24}O$, and a hydrocarbon, $C_{15}H_{24}$ (*9*, *10*). The inorganic portion is made up of sodium, potassium, calcium, and magnesium phosphates and a small amount of sulfate. Mention should be made that certain crude rubbers do not vulcanize very well and are therefore known as off-grade rubbers. This difficulty is due to a deficiency in the amount of fatty acids, which are removed in the course of preparation. The addition of stearic acid to these rubbers makes them vulcanize normally (*9*).

The Rubber Hydrocarbon and Its Purification

The old method of purifying the rubber hydrocarbon was to dissolve acetone-extracted crude rubber in benzene, let the solution stand until



WEIGHING THE SPRAYED RUBBER

The sprayed rubber before pressing is light in weight and resembles angel cake in color and texture.

Sprayed rubber is removed from the trays or movable floors and carted to the baling room adjoining. There it is weighed and separated into the amounts required in the standard compressed bale of 200 pounds each. A careful brushing with a steel wire brush is given the rubber before it is put in the compressor.

the insoluble particles separated out, then precipitate the hydrocarbon by pouring the solution into alcohol (*11*). Repetitions of this procedure give a fairly pure rubber hydrocarbon but it still contains some protein and other non-rubber constituents. Fractional precipitation of a petroleum ether solution in acetone gives a better product but it also is not always free from nitrogen (*12*). When acetone-extracted rubber is allowed to stand in petroleum ether or dry ethyl ether a goodly portion of the rubber hydrocarbon is dissolved out and diffuses into the solvent (*13*, *14*). This so-called diffusion rubber upon evaporation of the solvent is a very pure product but it accounts for only sixty to seventy per cent of the original hydrocarbon.

The best method of obtaining the total rubber hydrocarbon in a pure state is to treat latex (*15*) in an inert atmosphere with alkali, warm to 50°C., and allow it to cream; then repeat the alkali treatment a number of times with the cream and finally remove the remaining alkali by dialysis.

The rubber hydrocarbon is then coagulated by the addition of acetone or acetic acid, extracted with acetone to remove any remaining resins, and dried in a high vacuum. Such a product in thick pieces is colorless, transparent, elastic, and non-tacky. By this method it is possible to obtain a purified rubber hydrocarbon with a nitrogen content of less than one-hundredth of one per cent and free from protein.

The purified rubber hydrocarbon can be separated into two portions by extraction with absolute ether, the ether soluble portion being called "sol-rubber" or alpha-rubber and the insoluble portion "gel-rubber" or beta-rubber (*15*). This separation, however, is not exact because even after ten days of continuous extraction a constant condition is attained where only a very small but weighable amount goes into the ether each day; finally, after long treatment, it all dissolves (*16*). The portion ordinarily insoluble in ether amounts to approximately thirty-five per cent, but with other solvents it is somewhat lower. Sol-rubber is very elastic and gel-rubber is very tough and not so elastic. Both types give excellent analytical figures long known for that of the rubber hydrocarbon, $(C_5H_8)_x$.

Crude rubber was not a familiar substance to most people until recently when it has been seen as crêpe rubber soles. It should be stated, however, that most of the "crêpe rubber" soles used today are in reality vulcanized rubber soles made to look like crêpe rubber. Crêpe rubber is tough, strong, resilient, and elastic, and in such a state it is not possible to mix into it the necessary materials for vulcanization and manufacture. However, when it is worked between the rolls of a rubber mill it is "broken down" or masticated and becomes soft and plastic. Then it is possible to mix compounding ingredients into it. After vulcanization, the mixture shows the same general properties which it originally had, but to a much greater degree. Furthermore, it now holds these enhanced properties over a much greater range of temperature.

It is not known just what takes place when rubber is broken down. The process has been described as one of depolymerization and also as one of disaggregation. If it is the first type, then it is a chemical process; if it is the second type, it is a physical process. If it is depolymerization, then the unsaturation of the rubber hydrocarbon should increase per unit of weight but no such change has been noted, provided oxygen is kept away during the process (*17*). The increase in unsaturation may, however, be so small that it cannot be detected by any of the known methods.

It is of interest to note that the gel-rubber mentioned above, when broken down on the mill, in an atmosphere of carbon dioxide to prevent oxidation, becomes soluble in ether, and when ether solutions of sol-rubber are evaporated, after standing, traces of gel-rubber, insoluble in ether, are found. These are interesting points because it is believed by some

that these two different types can be changed one into the other in crude rubber under different conditions. Whether sol-rubber, however, is simply disaggregated gel-rubber and whether gel-rubber is aggregated sol-rubber still remains to be seen.

The pale crêpe of commerce is yellow in color. Ordinarily it would be dark colored, because bacterial action causes the formation of various colored materials, but this action is prevented in the preparation of good pale crêpe by the use of sodium bisulfite. The yellow color has now been found to be due to the presence of carotene (carotin), $C_{40}H_{56}$ (*18*). This yellow coloring matter, which is widely distributed in the vegetable kingdom, exists in the original latex to the extent of about 0.1 mg. per 100 grams of thirty-five per cent latex. It can be removed by extraction with acetone.

The chemical structure of the rubber hydrocarbon still remains chiefly as it was worked out by Harries (*19*) as follows:

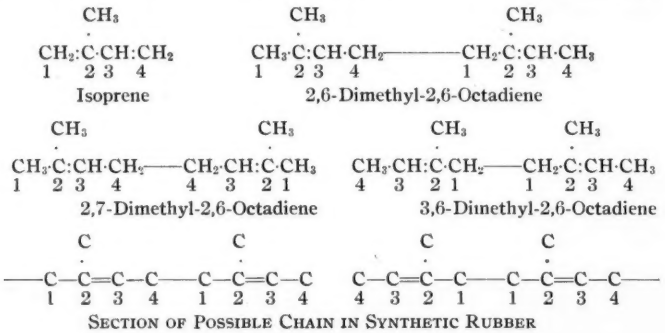
$$\left[\begin{array}{c} CH_3 \\ | \\ -CH_2-C=CH-CH_2- \end{array}\right]_x$$

Considerable work has been done by Pummerer (*20*) and by Staudinger (*21*) in an effort to show whether the molecule consists of a ring, or whether it is a long open chain with free valences at the ends. Up to a short time ago, the longest ring known was made up of only nine carbon atoms. Therefore, it was difficult for chemists to accept the idea of much larger rings existing in nature. However, Ruzicka (*22*) and his students have prepared much larger rings, one of them $C_{30}H_{60}$, consisting of thirty carbons and furthermore, they have shown that the chief constituent of natural civet, civetone, $C_{17}H_{26}O$, contains a ring of seventeen carbon atoms. Further work on this question will be watched with considerable interest.

Synthetic rubbers can be made by the polymerization of isoprene, but the only definite synthetic work that has been done to help substantiate the above formula for rubber is that by Midgley and Henne (*23*). They found that when metallic potassium is placed in isoprene, and ethyl alcohol slowly added to the mixture, a good yield of a light yellow oil results which upon analysis proves to be a mixture of 2,6-, 2,7-, and 3,6-dimethyl-2,6-octadienes. These isomers are the three possible dihydro dimers of isoprene resulting from a junction at the 1,4-, the 4,4-, and the 1,1-carbon atoms, respectively, and the addition of hydrogen to the 1,8-positions of each dimer. No trace of a compound of cyclic nature was detected.

These results help to prove that the synthetic rubber produced by contact of isoprene with the alkali metals is a long chain or a large ring formed of isoprene units linked together by means of their 1 and 4 carbon atoms. The methyl groups would not necessarily be in regular order as they probably are in natural rubber. The structural formulas of isoprene

and of the three dimethyloctadienes are given below, and also a possible skeleton structure of a section of a synthetic rubber chain (*24*). The numbers are the same in all cases, and the junctions of the isoprene units are indicated by longer bonds. If such a synthetic rubber were ozonized, it can be seen that the decomposition products would be levulinic aldehyde, succinic aldehyde (or acid), and acetonyl-acetone. As a matter of fact, these are the products actually obtained, although the proportions vary considerably, levulinic aldehyde being the greatest in amount (*25*).



SECTION OF POSSIBLE CHAIN IN SYNTHETIC RUBBER

Chemical Derivatives

It has been known for a long time that bromine, hydrogen chloride, hydrogen bromide, and sulfur add to rubber to form definite combinations, according to chemical analysis. Hydrogen has now been added catalytically (*26*, *27*), and this reaction proves beyond a doubt that the unsaturation of rubber is similar to that of olefins of finite molecular weight. This point had previously been disputed. The hydrorubber is somewhat like paraffin, is not affected by the usual vulcanizing agents, sulfur and sulfur chloride, and reacts with bromine only by substitution. Oxygen (*26*) also adds in the presence of a catalyst to form a saturated compound $(C_5H_8O)_x$, and a compound with the same composition results from the action of perbenzoic acid (*26*) on rubber. Rubber bromide reacts with phenol and its homologs with the loss of hydrogen bromide and the formation of a phenol derivative (*28*), which can be alkylated (*29*, *30*), esterified (*30*), and even coupled with diazo-compounds to form dyes (*30*, *31*). Nitrosobenzene (*32*, *33*) and rubber form a nitrone, $C_5H_6 : \overset{\overset{O}{\cdot\cdot}}{N} \cdot C_6H_5$. Ethyl *o*-nitrosobenzoate reacts similarly, and the product on hydrolysis gives the free acid which is insoluble in water. The potassium salt is soluble; its solution has the character of a true salt solution and therefore it is a colloidal electrolyte with a colloidal anion and molecularly dispersed cation.

When rubber hydrochloride is heated in solution with pyridine it is decomposed and the $(C_5H_8)_x$ compound regenerated is a mixture of isorubbers (*34*). However, when the hydrochloride is heated in solution with more hydrogen chloride in the presence of zinc dust (*35*, *36*), it is also decomposed; the product has the same composition as rubber itself but the unsaturation is much less than that of the original rubber. It is believed that the loss of some of the double bonds is due to formation of internal cycles, and the rubber is said to be polycyclicized or isomerized. Several different types of these isomerized products can also be made by heating rubber with organic sulfonyl chlorides and organic sulfonic acids (*37*). They are thermoplastic, that is, they can be molded under heat, and resemble gutta-percha, hard balata, and shellac, according to the method of treatment. The silent electric discharge also isomerizes rubber (*38*). Sulfuric acid on rubber in solution (*39*), or heated directly in a rubber mix (*37*), produces somewhat similar products, although when prepared in solution they are usually insoluble and practically non-thermoplastic.

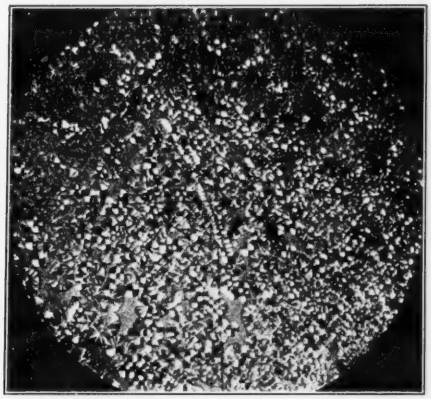


FIGURE 4.—CRYSTALS OF RUBBER HYDROCARBON

Physical Structure of Rubber

Crystals of Rubber.—A few years ago Pummerer and Koch (*12*), working with a purified rubber hydrocarbon prepared by fractional precipitation, on allowing it to cool after an acetone extraction, noted that a portion of it separated in the form of crystals. The chemical analysis showed them to have the formula $(C_5H_8)_x$ and crystallographic analysis indicated three crystalline varieties in six different crystalline formations. One of their photographs is shown in Figure 4. Others tried to repeat this work but failed and it is the understanding of the writer that even Professor Pummerer has not been able to obtain these crystals again. Recently, Dr. W. H. Smith, working under Dr. E. W. Washburn of the Bureau of Standards, has isolated similar crystals from ether solutions of purified rubber at low temperatures, and an announcement of this work has been published in the newspapers, and in the Bureau's *Technical News Bulletin* (*40*). Crystalline ether sol-rubber was obtained at 60° to 70°C. below zero from ether solution, and crystalline ether gel-rubber was obtained

at approximately 80°C. below zero from a mixture of ethyl benzene and ether. The crystals show bi-refringence under polarized light.

Distillation.—Now that rubber has been crystallized, the even later announcement that rubber has been distilled is not so exciting. The same *Technical News Bulletin* that told of the re-accomplishment of the crystallization of rubber also tells of the distillation of rubber. This was done without decomposition by heating it in a high vacuum to the temperature of boiling water. The distilled rubber has all the common characteristics of ordinary rubber, but the rate of distillation is not great, only a few milligrams being obtained during several months (*41*).

Solution.—The rubber hydrocarbon dissolves or is dispersed in benzene, gasoline, chloroform, carbon bisulfide, anhydrous ethyl ether, etc. It is not known, however, whether the particles in these colloidal solutions consist of molecules of the rubber hydrocarbon or of aggregates of them. In fact, it is not known whether the molecules are of the same size or not. Staudinger (*42*) is of the opinion that the molecules of rubber are large, macromolecules, that they contain about one thousand isoprene nuclei in a long chain, and that the great length of these chains gives the characteristic properties of high viscosity to rubber solutions.

FIGURE 5.—X-RAY DIFFRACTION PATTERN FOR UNSTRETCHED RAW RUBBER

When a solution of rubber is boiled for several hours in the ordinary apparatus unprotected from air, and then cooled, its viscosity is found to be very much less than before the heating. However, if oxygen is rigidly kept out of the solution, the viscosity afterward is the same as before.

X-Rays.—X-ray studies (*43*) have shown that unstretched raw rubber produces a diagram typical of an amorphous material, that is, a single, broad, diffuse ring (Figure 5). As raw rubber is stretched beyond seventy-five per cent elongation, the X-ray diagram shows a marked change. In addition to the amorphous ring, which is always evident but decreases in intensity with increase in elongation, there appear definite interference spots which become sharper and more distinct the greater the stretching, but retain the same positions (Figures 6 and 7). The entire phenomenon is reversible if the sample is not too strongly stretched, the amorphous diagram being obtained again when the tension is released. If, however, the rubber is stretched very slowly, no interference spots appear at all. When the rubber is stretched, cooled, and then released, the interferences

remain unchanged. When the stretched rubber is heated, the interferences become less intense and disappear at 60°C. They also disappear when the stretched rubber is placed in an atmosphere of the vapor of a solvent such as benzene. The intensity of the diffraction interferences increases in direct proportion to the percentage elongation of the stretched rubber, and this increase in intensity is explained by the continual appearance of new diffracting crystal-like individuals. The evidence seems to support the contention that the crystals do not exist as such prior to the stretching, although rubber which has stood for some time at low temperatures and has become opaque and hard, gives a pattern of sharp, concentric rings, indicative of small crystal grains in random orientation (*44*). The same general results with X-rays have been obtained with both sol- and gel-rubber and with eighteen different samples of crude rubber from various parts of the world. It is evident, therefore, that the structure of raw rubber as revealed by this method is independent of the type or the origin of the rubber and is directly related to the structure of the rubber hydrocarbon (*45*). Also, the stretching of rubber is a molecular, not a macroscopic, phenomenon.

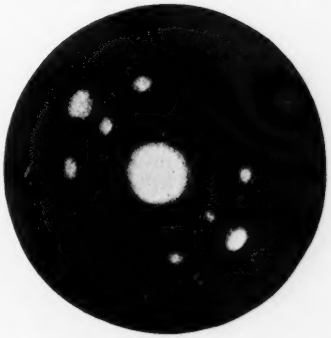


FIGURE 6.—X-RAY DIFFRACTION PATTERN FOR RAW RUBBER STRETCHED 500%

X-ray studies also indicate that the rubber hydrocarbon consist of long chains of isoprene groups and that these long chains probably exist as spirals which form definitely aligned fibers when the rubber is stretched. Further work in this field will be awaited with considerable interest.

FIGURE 7.—X-RAY DIFFRACTION PATTERN FOR VULCANIZED RUBBER STRETCHED 500%
Note sharpness of spots as compared with Figure 6.

If a strip of raw rubber is stretched while warm and cooled quickly, under tension, it remains as a thin strip and is then known as "racked rubber." If the tension is released and the racked rubber warmed, it will contract, but not to its original condition. Some of the strains are evidently "frozen in." Repeated racking may stretch the rubber to 9000 to 10,000 per cent elongation (*46*). Such racked rubber shows a very intense X-ray

FIGURE 8.—RAW RUBBER, UNSTRETCHED AND STRETCHED, FROZEN AND THEN SHATTERED
Note the fibrous structure of the stretched rubber.

diagram. If stretched or racked rubber is frozen with liquid air and then struck with a hammer, it splits into fibers. Unstretched rubber under these conditions shows a conchoidal fracture. Hock (*47*), who did this work, was also able to show the same effect with "diffusion" rubber and, working at lower temperatures, with vulcanized rubber. He reasoned, therefore, that the fibrous structure is a property of the molecules or molecular aggregates common to all modifications. The accompanying photographs (Figures 8 and 9) show very well the fibrous structure of these different rubbers.

Rubber, upon being stretched, gives off heat, and, when it is immediately allowed to return to its original position, becomes cold again. This generation of heat during the stretching, which is known as the Joule effect, is the opposite of what happens with most substances. For example, if a piece of copper or steel is stretched, it absorbs heat and becomes colder. Recent data show that the amount of heat evolved is directly proportional to the degree of elongation (*48*), just as the intensity of the X-ray diagram is also directly proportional to the degree of elongation.

When a solution of rubber in petroleum ether is allowed to form on mercury a film insufficient to cover the entire area, its thickness as given by Sheppard, Nietz, and Keenan (*49*) is only 1.5 Å.* This is very small as contrasted, for example, with a molecular film of stearic acid on water which is 21 Å. thick. It appears, therefore, that the rubber particle is of the "macromolecular" type and lies very flat under such conditions.

FIGURE 9.—VULCANIZED RUBBER, UNSTRETCHED AND STRETCHED, FROZEN AND THEN SHATTERED
Note similarity to raw rubber.

* Å—Ångström unit. 1 Å—0.0001 micron or 1/100,000,000th cm.

Vulcanization

When a mixture of rubber and sulfur is heated under proper conditions at "vulcanizing" temperatures, around 140°C., there takes place a gradual change from a plastic tacky mixture to a very elastic, very strong, non-tacky product, which is familiar to all in the form of rubber bands, inner tubes, etc. In the industry this condition is designated as a good "cure." The early stages are known as "under cures," and the later stages, when the product on longer heating becomes weaker, as "over cures." The most important difference between raw and vulcanized rubber is the increased resistance to plastic flow, or its permanent set. Properly vulcanized rubber, when stretched and allowed to return, goes back practically to its original shape, whereas raw rubber does not. Furthermore, this stretching and returning can be done many times without causing any particular change in the original shape. The time of heating for a good rubber-sulfur cure, in the absence of an accelerator, is about three hours, and such a vulcanizate will contain at least two and one-half per cent of combined sulfur. With larger amounts of sulfur, a limiting addition-product, $(C_5H_8S)_x$, is formed, which contains thirty-two per cent of sulfur. Ordinary commercial hard rubber approaches this product, since it contains twenty-five to thirty per cent of combined sulfur. Sulfur is soluble in both raw and vulcanized rubber, and the portion uncombined with the hydrocarbon, the "free" sulfur, slowly crystallizes out on the surface as a grayish powder, commonly known as "bloom."

PHOTOMICROGRAPH SHOWING DENDRITIC FORM OF SULFUR CRYSTALLIZING IN A RUBBER-SULFUR MIXTURE

There is no doubt that during vulcanization sulfur adds chemically to the rubber, but this fact does not fully explain vulcanization. No one has ever been able to isolate any of the addition products except the one containing thirty-two per cent of sulfur: the sulfur in some way seems to combine with the entire mass of rubber. It is not even known whether an atom adds to a double bond forming an ethylene sulfide type, or whether two atoms unite with two double bonds forming a bridge either in the same molecule or between different molecules or aggregates.

There have been many theories of vulcanization other than the sulfur-addition theory put forward by different investigators, but it is not possible to discuss them here. For those who are especially interested the following references may be helpful (*50*).

Acceleration

Accelerators (*51*) of vulcanization not only shorten the time of vulcanization, but also make it possible to use lower temperatures and to obtain products with enhanced physical properties and frequently with better aging qualities. Accelerators are used in small amounts, approximately 0.01 to 1.0 part with 100 parts of rubber. Zinc oxide is often necessary for proper activation of the accelerator. Inorganic accelerators such as litharge and magnesia have been known for a long time, but organic accelerators, used commercially in 1906 by Oenslager (*52*), were first given to the world in the published patents of Bayer and Co. (*53*) in 1912. Oenslager used aniline and thiocarbanilide, and the Bayer patents disclosed the use of piperidine and its CS_2-addition product. The latter is typical of an "ultra-accelerator." In its presence rubber can be vulcanized in two to three minutes at 140°C., and on standing for several weeks at ordinary temperatures. It will also gel a rubber cement containing sulfur and zinc oxide. Most organic accelerators contain nitrogen, some nitrogen and sulfur, and some, such as the xanthates, sulfur but no nitrogen. They apparently act by causing the formation of an active form of sulfur.

Aging

A rubber band around papers set aside in a drawer became hard and brittle, the side wall of an automobile tire cracked and crumbled, the rubber covering of a raincoat allowed to remain in the sun on the beach changed to a sticky mass; these familiar changes are typical of the aging of ordinary vulcanized rubber. All rubber goods, however, do not deteriorate like these. The old red hot-water bottles and red rubber bands showed excellent keeping qualities, and on this account even today many people still think of rubber as being red. These articles were vulcanized with crimson antimony sulfide (a polysulfide), and for some little understood reason such articles age very well. Nowadays very little "crimson antimony" is used, but since people have been so used to the splendid aging qualities of the goods manufactured by its use, articles are made with a red dye added to imitate the color and an organic "age-resistor" to assure proper keeping qualities. The short life of ordinary rubber goods has kept rubber from being used in many places where it would be of great assistance, especially in building operations, machines, etc., and now that its life can be prolonged considerably, whole new fields have been opened up.

Aging is the result of the action of air and light, separately or together. Only comparatively recently have chemists studied this question intensively, and they have found that certain chemicals can be added to rubber to prolong its life. These chemicals are termed "anti-agers," "age-resisters," or "antioxidants." They are usually organic compounds, and the

most useful have been the condensation products of aliphatic aldehydes and aromatic amines (acetaldehyde and aniline, and acetaldol and α-naphthylamine), and the phenyl naphthylamines. It is easy enough to test a chemical for its action as an accelerator of vulcanization because the time factor is small, but ordinary aging requires a long time. In order to provide an accelerated aging test, Geer (*54*) used an oven in which strips of rubber were hung and through which warm air, previously heated to 70°C., was passed. The strips of rubber were removed every other day during two weeks and tested for reduction of tensile strength and elongation. This method gives good predictions except for articles containing traces of copper or for those exposed to sunlight (*55*). Another method, and one very widely used today, is that devised by Bierer and Davis (*56*). The test pieces are kept in a bomb under 300 pounds pressure of oxygen and at about 60°C. This test is much shorter, and, as in the Geer oven test, conclusions may also be drawn from the tensile strength and elongation. It does not predict sun cracking.

Newer Practical Developments

New accelerators and new antioxidants are being developed, these generally being modifications of older well-known classes. It has been calculated that the use of accelerators and antioxidants has saved the consumers upwards of $50,000,000 annually (*57*). Much work is also being done on developing new and better methods for doing older, well-known operations.

Engineers are making more and more use of rubber in order to take advantage of its remarkable resistance to abrasion and its shock-absorbing quality. This is partly made possible through the developments of adhesives for bonding rubber to metal (*58*, *37*). In an automobile the engine literally rides in rubber through the use of rubber motor mounting blocks, and spring shackles are embedded in rubber. Chemical equipment is lined with rubber, and thus the strength of steel and the resistance of rubber to corrosion are combined in building important apparatus. Ball mills for grinding minerals, steel chutes, pumps and valves, barrels, tanks, tank cars, etc., are lined with rubber, and the rubber vulcanized in place.

A very novel and important development is the use of rubber on the forward edge of airplane wings and struts for preventing the formation and accumulation of ice (*59*). The rubber is specially treated to keep ice from adhering to it, and when in position it can be stretched by the action of inflatable rubber bags placed underneath and controlled from the cockpit. Thus a former terror of the aviator in winter will henceforth be eliminated.

Probably the most interesting manufacturing developments are being made with latex. The extent of these developments can be seen from the

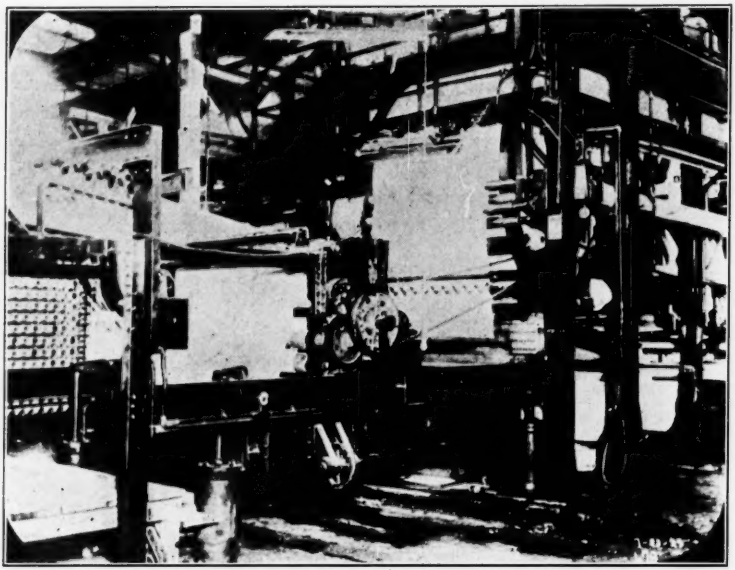


FIGURE 10.—WEB CORD FABRIC MANUFACTURE

figures for importations of latex during the first six months of 1930, namely, 18,501,966 gallons, which is equivalent to about 2360 tons of dry rubber. A very large proportion of this amount is used for the manufacture of web cord fabric (*60*) for automobile tires. The separate cords are passed through a bath of properly prepared latex, dried, and then run side by side over a roll from which they emerge as a sheet of fabric held together by the adhesiveness of the rubber surrounding the cords—a fabric which is all warp and no woof, so to speak. (See Figure 10.)

Latex is also used for impregnating paper (*61*) to give it greater flexing and to increase its bursting strength. Impregnated animal hair is used for stair treads and non-slipping rugs (*62*), and impregnated paper and cloth with a coating of finely ground wool, leather, or cork is said to be an excellent imitation of suede and buckskin (*63*). Mohair upholstery (*64*) with the base of the fibers embedded in rubber now adorns many automobiles, and rugs made similarly are filling a growing demand.

Thickened latex, formed by creaming as mentioned above, or by evaporation in the presence of a protective agent (Revertex) (*65*), is used in many places where solutions containing flammable solvents were formerly employed. Fabrics can be spread with such a thickened latex, and gloves can be dipped in it, without any danger of fire or explosion. Sealing com-

positions are made from it for air-tight pressure cans (*66*), also adhesives for shoes (*67*), and special mixes for making sponges (*68*). Inner tubes for automobiles can also be formed on a filtering medium (*69*).

Since the rubber particles in latex carry a negative charge of electricity they can be made to deposit electrolytically on a metal anode (*70*). Such a coating is sometimes filled with holes from gases given off at the same place, but this difficulty can be obviated by placing the anode in an electrolyte inside a porous form, and then the rubber deposits in a uniform layer on the outside of this porous form (*71*). The first method gives a rubber-coated metal, for example, a rubber-coated wire basket, and the second method gives a tobacco pouch, a bathing slipper, an inner tube, all depending on the porous form used.

As mentioned above latex can be vulcanized and such vulcanized latex can be used direct for coating fabrics, for making thin sheet rubber, etc., without further vulcanization (*7*).

Rubber goods prepared directly from latex are very strong and durable, probably because the rubber has not been worked on a mill and calender, which process produces a grain and also "breaks down" the rubber.

With plenty of rubber at a low price and with every reason to expect there will continue to be plenty of it at a reasonably low price, the rubber industry looks forward to many new and useful developments. It presents an enticing field in which to study and work.

Literature Cited

(*1*) PERRY, *India Rubber World*, **68**, 483 (1923).

(*2*) VON WEIMARN, *Repts. Imp. Ind. Research Inst.* (Osaka, Japan), **9**, No. 5 1–50 (1928); *Rubber Chem. & Tech.*, **2**, 108 (1929).

(*3*) TRAUBE, Brit. pat. 226,440 (1924); *Chem. Abstr.*, **19**, 2146 (1925); *Gummi-Ztg.*, **39**, 434 (1925). MCGAVACK, Brit. pat. 294,002 (1927); U. S. pat. 1,740,994 (1929).

(*4*) DE VRIES and BEUMÉE-NIEUWLAND, *Arch. Rubbercultuur*, **11**, 371, 390 (1927); *Chem. Abstr.*, **22**, 331 (1928).

(*5*) PRATT, Brit. pat. 233,370 (1923); *India Rubber World*, **70**, 785 (1924); *Rubber Age* (N. Y.), **15**, 15, 299 (1924). TRUMBULL and DICKSON, U. S. pat. 1,513,139 (1924). TRUMBULL, "Colloid Symposium Monographs," Vol. VI, The Chemical Catalog Co., New York City, **1928**, p. 215.

(*6*) MCGAVACK and SHIVE, U. S. pat. 1,699,369 (1929).

(*7*) SCHIDROWITZ, Brit. pat. 193,451 (1923); 208,235 (1923); *Ind. Eng. Chem.*, **18**, 1147 (1926).

(*8*) EATON, "The Preparation and Vulcanization of Plantation Para Rubber," Kuala Lumpur, Federated Malay States (1918).

(*9*) WHITBY, DOLID, and YORSTON, *J. Chem. Soc.*, **129**, 1448 (1926). BEDFORD and WINKELMANN, *Ind. Eng. Chem.*, **16**, 32 (1924). SEBRELL and VOGT, *ibid.*, **16**, 972 (1924).

(*10*) BRUSON, SEBRELL, and VOGT, *Ind. Eng. Chem.*, **19**, 1187 (1927).

(*11*) HARRIES, "Untersuchungen über die Natürlichen und Künstlichen Kautschukarten," Springer, Berlin, **1919**, p. 7.

(12) PUMMERER and KOCH, *Ann.*, **438**, 295 (1924). WEBER, C. O., "The Chemistry of India Rubber," Chas. Griffin & Co., London, **1909**, p. 8.
(13) CASPARI, *J. Soc. Chem. Ind.*, **32**, 1041 (1913).
(14) PUMMERER and MIEDEL, *Ber.*, **60**, 2148 (1927); *Rubber Chem. & Tech.*, **1**, 163 (1928).
(15) PUMMERER and PAHL, *Ber.*, **60**, 2152 (1927); *Rubber Chem. & Tech.*, **1**, 167 (1928).
(16) WHITBY, *Trans. Inst. Rubber Ind.*, **5**, 184 (1929); **6**, 40 (1930).
(17) FISHER and GRAY, *Ind. Eng. Chem.*, **18**, 414 (1926).
(18) EATON and FULLERTON, *Rubber Research Inst. Malaya, Quarterly J.*, **1**, 135 (1930); *Chem. Abstr.*, **24**, 3923 (1930).
(19) HARRIES, "Untersuchungen über die Natürlichen und Künstlichen Kautschukarten," Springer, Berlin, **1919**, p. 229.
(20) PUMMERER and MANN, *Ber.*, **62**, 2636 (1929).
(21) STAUDINGER, *Kautschuk*, **1929**, pp. 94, 126.
(22) RUZICKA, *Helv. Chim. Acta*, **11**, 496 (1928).
(23) MIDGLEY and HENNE, *J. Am. Chem. Soc.*, **51**, 1294 (1929).
(24) STAUDINGER, *Ber.*, **53**, 1083 (1920).
(25) STEIMMIG, *Ber.*, **47**, 350, 852 (1914). HARRIES, *ibid.*, **47**, 573 (1914); **48**, 863 (1915).
(26) PUMMERER and BURKHARD, *ibid.*, **55**, 3458 (1922).
(27) STAUDINGER and FRITSCHI, *Helv. Chim. Acta*, **5**, 785 (1922).
(28) WEBER, C. O., *Ber.*, **33**, 791 (1900).
(29) FISHER, GRAY, and MCCOLM, *J. Am. Chem. Soc.*, **48**, 1309 (1926).
(30) GEIGER, *Helv. Chim. Acta*, **10**, 530, 539 (1927).
(31) FISHER, U. S. pat. 1,734,270 (1929).
(32) BRUNI and GEIGER, *Atti accad. Lincei* (6) **5**, 823 (1927); *Rubber Age* (N. Y.) **22**, 187 (1927).
(33) PUMMERER, ANDRIESSEN, and GÜNDEL, *Ber.*, **60**, 1591 (1928).
(34) HARRIES, "Untersuchungen über die Natürlichen und Künstlichen Kautschukarten," Springer, Berlin, **1909**, p. 21.
(35) HARRIES and EVERS, *Wiss. Veröffentlich. Siemens-Konzern*, **1**, Heft 2, 87 (1921).
(36) STAUDINGER and WIDMER, *Helv. Chim. Acta*, **9**, 529 (1926).
(37) FISHER, U. S. pat. 1,605,180 (1926); *Ind. Eng. Chem.*, **19**, 1325 (1927). FISHER and MCCOLM, *ibid.*, **19**, 1328 (1927).
(38) FROMANDI, *Kautschuk*, **4**, 185 (1928).
(39) KIRCHHOF, *ibid.*, Jan., **1926**, p. 1.
(40) DEPT. COMMERCE, *Tech. News Bull.*, No. 161, 85 (1930).
(41) WOLF, *Rubber Age* (N. Y.), **28**, 79 (1930).
(42) STAUDINGER, *Kautschuk*, Aug., **1925**, p. 5; **1927**, p. 64.
(43) KATZ, *Chem.-Ztg.*, **49**, 353 (1925); *Gummi-Ztg.*, **41**, 2035, 2091 (1927). HAUSER and ROSBAUD, *Kautschuk*, **1927**, p. 17. CLARK, *India Rubber World*, **79**, 55 (Feb., 1929). HAUSER, HÜNEMÖRDER, and ROSBAUD, *Kautschuk*, **1927**, p. 228.
(44) HAUSER and ROSBAUD, *Kautschuk*, p. 17 (1927).
(45) HAUSER, *Naturwissenschaften*, **15**, 100 (1927).
(46) FEUCHTER, *Kautschuk*, **1926**, pp. 260, 282.
(47) HOCK, *Gummi-Ztg.*, **39**, 1740 (1925); *Kautschuk*, **1926**, p. 88; **1927**, p. 125.
(48) HOCK and BOSTROEM, *Gummi-Ztg.*, **41**, 1112 (1927).

(*49*) SHEPPARD, NIETZ, and KEENAN, *Ind. Eng. Chem.*, **21,** 126 (1929).
(*50*) KELLY, in BEDFORD and WINKELMANN'S "Systematic Survey of Rubber Chemistry," Chemical Catalog Co., New York City, **1923,** pp. 53–73. LUFF, "The Chemistry of Rubber," D. Van Nostrand, Inc., New York City, **1924,** p. 103. BACON, *J. Phys. Chem.*, **32,** 801 (1928).
(*51*) SEBRELL, in BEDFORD and WINKELMANN'S "Systematic Survey of Rubber Chemistry," Chemical Catalog Co., New York City, **1923,** pp. 23–52. DINSMORE and VOGT, *Trans. Inst. Rubber Ind.*, **4,** 85 (1928).
(*52*) GEER and BEDFORD, *Ind. Eng. Chem.*, **17,** 393 (1925).
(*53*) BAYER AND CO., Ger. pat. 250,920; 255,680 (1911).
(*54*) GEER, *India Rubber World*, **55,** 127 (1916). GEER and EVANS, *ibid.*, **64,** 887 (1921).
(*55*) CADWELL, *Ind. Eng. Chem.*, **21,** 1017 (1929).
(*56*) BIERER and DAVIS, *Ind. Eng. Chem.*, **16,** 711 (1924).
(*57*) Recent Economic Changes in the U. S., Vol. I (1929).
(*58*) GEER, U. S. pat. 1,617,588 (1927).
(*59*) *India Rubber World*, **82,** 70 (May, 1930).
(*60*) *Rubber Age* (N. Y.), **21,** 553 (1927).
(*61*) KAYE, *India Rubber J.*, **64,** 435 (1922).
(*62*) *India Rubber World*, **82,** 69 (Aug., 1930).
(*63*) *Ibid.*, **82,** 67 (Aug., 1930).
(*64*) *Automobile Topics*, **94,** 300 (1929).
(*65*) HAUSER and FOULD, *India Rubber J.*, **74,** 700 (1927); *India Rubber World*, **75,** 315 (1927); Brit. pat. 293,771 (1927).
(*66*) *India Rubber World*, **75,** 135 (1926).
(*67*) HAUSER, "Latex," trans. by KELLY, Chemical Catalog Co., New York City, **1930,** p. 141.
(*68*) SCHIDROWITZ and GOLDSBROUGH, Dutch pat. 3518.
(*69*) HOPKINSON and GIBBONS, U. S. pat. 1,542,388 (1925); *India Rubber World*, **78,** 59 (Aug., 1928); *India Rubber Tire Rev.*, **28,** 48 (1928).
(*70*) SHEPPARD and EBERLIN, *Ind. Eng. Chem.*, **17,** 711 (1925). SHEPPARD, *Rubber Age* (N. Y.), **21,** 76 (1927).
(*71*) KLEIN, *Rubber Age* (N. Y.), **24,** 319 (1928).

Strange Parasitic Plant May Be Good Food Source. A plant with flowers but no leaves, that gets most of its food by tapping the roots of other plants and grows to be ten or twenty times as heavy as its host, yet without causing the latter any apparent injury, was described before a recent meeting of the National Academy of Sciences by Walter T. Swingle of the U. S. Department of Agriculture. It has the further distinction of being good for human food, and of maturing a good crop on as little as three inches of rain a year—believed to be a record for food plants possible in dry regions.

It was originally discovered about eighty years ago in the desert near the California-Mexico boundary, but until a little over a year ago remained a great rarity. Now, however, it has been rediscovered in great abundance, and has received its first thorough botanical study. The part used for food is the thick, fleshy root, in which the plant stores water and a reserve of food material. The original discoverers found the Papago Indians using it for food, and when they tried it roasted over a fire they found it very good. Mr. Swingle suggested that inasmuch as no other useful plant can be induced to grow in this arid region, it might be worth the white man's time to follow the lead of the Indian on a larger scale.—*Science Service*

THE EDUCATION OF SPANISH WOMEN IN CHEMISTRY

MARY LOUISE FOSTER, SMITH COLLEGE, NORTHAMPTON, MASSACHUSETTS

Conservative Spain is changing its ancient form of education, according to which the textbook was memorized page by page, for the modern scientific methods. This has been accomplished through the influence of a group of men and women, inspired by the reformer, Don Francisco Giner de los Rios, and organized by the Government under the name of the "Junta para ampliación de los estudios científicos." This "Junta" or Board established "Residencias" modeled after the English college, with laboratories and libraries; offered fellowships for study abroad; and provided places for study and research for the returning Fellows. The women have shared in these opportunities and now, on graduation from the University of Madrid, are registered and allowed to practice as pharmacists, chemists, dentists, lawyers, or physicians, according to their choice of career.

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Education in the sciences, based on practice in the laboratory, has been slow to develop in Spain. Not only were the ancient methods of instruction of memorizing the text opposed to the modern methods but the excessive cost of laboratory maintenance was prohibitive. However, changes are coming rapidly, have, in fact, already come in the University of Madrid, due to the influence and unremitting efforts of a splendid group of men and women who are inspired by the highest ideals for education.

This group is known as the "*Junta para ampliación de los estudios científicos*" (board for the extension of scientific studies), a government organization, the members of which were, for the most part, students of Don Francisco Giner de los Rios, a much-beloved professor of the University of Madrid. The Secretary of the *Junta* is Don José Castillejo, who for many years has given the most active, unselfish, and intelligent service to this cause of education. The methods of reform initiated here have been in general those of England and Germany. They consisted in the first place of *Residencias* with dormitory facilities combined with recitation rooms and laboratories similar to the English college; and, secondly, of fellowships for study abroad. On the return of these fellows, the need of libraries and laboratories for research was recognized and, slowly, these too have come into existence. Means for publication of the results of study and research have been supplied. Organized in 1903, the work of these enthusiasts for modern education is now bearing fruit.

The University of Madrid, founded by Cardinal Cisneros of the Court of Ferdinand and Isabella, has always been open to women, who, however, seldom availed themselves of this opportunity for study. The women more than the men have held to the customs of seclusion derived from Moorish influence. This custom has changed slowly, but steadily and

RESIDENCIA DE SEÑORITAS, 53 FORTUNY STREET, MADRID, SPAIN

more rapidly in recent years. In 1920, when I first came in contact with Spanish education, most of the women students of the University were registered in the School of Pharmacy, always a favorite with them in Spain. There were only one or two studying chemistry pure and simple. Education in chemistry consisted in committing to memory the words of the textbook. Can you imagine a more Herculean task! I remember that one of those girls, a student of mine at the time, said to me that she expected to fail the final examination because she could not remember that in experiment 20 on page 62, 10 cc. of HCl of sp. gr. 1.01 were required, whereas in experiment 40, on page 75, 5 cc. were required! Let me say here that she did *not* fail, that she owns her own pharmacy with two laboratories in Malaga and last summer toured Germany in her own automobile!

The instruction in laboratory practice at that time was limited to a couple of weeks for each section. It was not because the professor advocated that method, but because the class was very large and the laboratory very small. There was no laboratory at all in the *Residencia* for women.

On invitation of the *Junta* in coöperation with the International Institute for Girls in Spain, an American organization with a splendid record for secondary education, I went in September, 1920, to teach American laboratory methods to those young women of the University of Madrid, residing in the *Residencia de Señoritas* of which Doña María de Maeztu is the able director. I offered courses of four hours a week in qualitative

DOÑA MARÍA DE MAEZTU Y WHITNEY
Directora of the Residencia de Señoritas.

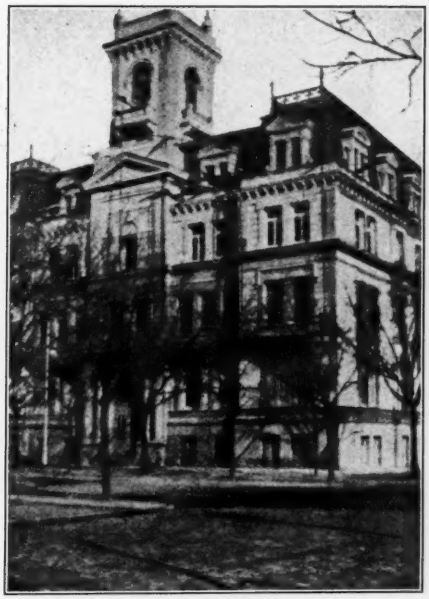
and quantitative analysis. Every place was eagerly subscribed for and four sections were organized with the laboratory filled to capacity. In spite of many handicaps in an equipment, which, in absolutely no sense, equaled even the simplest and poorest of our laboratories, enthusiasm and hard work prevailed and those students acquired before the end of the course a good technic and certainly an understanding of scientific method. Many of those first classes now have their own pharmacies in different cities of Spain. They are real pharmacies for the preparation and sale of medicines, with absolutely none of our American accessories of lunch-counter, cosmetics, and candy. Another young woman is head of her section of vaccines in the Provincial Laboratory of Zamora; two others are physicians and one is a dentist; still another is connected with the Customs Laboratory. It is evident that the women are penetrating every branch of professional life.

The work of those first two years was continued with success by my assistants. In June, 1927, I returned to Madrid, again on invitation of the *Junta* and the International Institute for Girls in Spain, to draw plans for the equipment of a new laboratory* which they had erected in the meantime in the garden of the *Residencia de Señoritas* and to supervise the installation of gas, water, and desks. As far as I was able, I reproduced my own laboratory in Smith College. Two laboratories were furnished, one for qualitative analysis with places for twenty-two students and another for quantitative analysis with places for ten students. The laboratories were opened for use in January, 1928, to the great delight of the students. The luxury of having their own desks with full equipment of reagents, apparatus, and other necessities was a new experience and

* *Editor's Note:* This laboratory was dedicated on March 1, 1928, and was appropriately named the "Foster Laboratory" after the author of this article.

they entered into the full enjoyment of it with enthusiasm.

In the university itself changes had come. Adjoining property had been purchased and in 1928 laboratories with modern equipment for teaching inorganic, analytical, and organic chemistry were opened. A library was also established in the same building. More students were registering for strictly professional work, for pure chemistry and for medicine; a thesis was being required and research was being initiated for the Ph.D. degree. And before the end of the academic year, Professor Casares, head of the department of chemistry, sailed with others for the United States to study the ground plan and organization of our American universities for the benefit of the new *Ciudad Universitaria* which is being erected in honor of Alfonso XIII. One building is already in use.

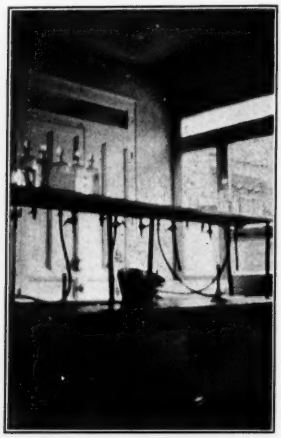


ALICE GULICK MEMORIAL BUILDING, MADRID, SPAIN

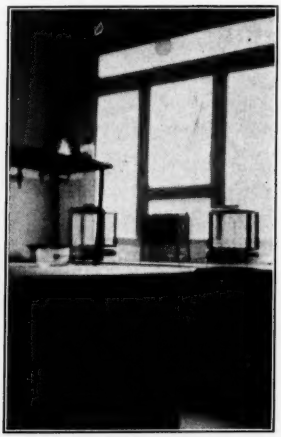
This building contains the library, recitation rooms, and part of the *Residencia de Señoritas.*

The great and pressing need, far greater than the same need in the United States, is the education of the women in the chemistry and scientific use and preparation of food. Courses in domestic science and economy and the relation of food to health are in my opinion very, very much to be desired; in fact the very sort of thing which the American Chemical Society is inaugurating in the United States with the help of the women's clubs. Unfortunately, there is no similar organization in Spain.

FOSTER LABORATORY, RESIDENCIA DE SEÑORITAS, MADRID



LABORATORY FOR QUALITATIVE ANALYSIS



LABORATORY FOR QUANTITATIVE ANALYSIS

Foster Laboratory, Madrid.

The *Instituto nacional de física y química*, constructed under the patronage of the Rockefeller Foundation, now nearing completion, the *Laboratorio de Ramón y Cajal* for biological research, the Museum of Natural History for agricultural study, all offer opportunity for scientific research, but the application of much of this to the home and to the betterment of daily living is lacking. Undoubtedly it will come, for I have found the Spaniard eager to take advantage of the new methods although change in ancient customs usually comes by slow modification, and people for the most part actively resent reform in their manner of living.

Calcium Chloride Used in Coal Treatment. Coal to which 30 or 40 pounds of chemicals have been added for each ton to allay dust should be sold without allowance for the additional weight of the chemicals, in the opinion of I. L. Miller, commissioner of weights and measures of Indiana.

But the purchaser should clearly understand that the coal has been chemically treated, it has been held. Use of the phrase, "dustless coal," was condemned as conveying a wrong meaning because after treatment the fine particles which make up dust are still in the coal though they are not floating around in air.

Calcium chloride, a deliquescent chemical, meaning that it absorbs quantities of water rapidly and holds it a long time, is widely used for this treatment. It is the same dust-allaying agent often applied to earth, gravel, and stone roads. Coal sprinkled with water will liberate dust again as soon as it dries, whereas calcium chloride and similar materials are effective for a whole year.—*Science Service*

CHEMISTRY IN PREHISTORIC AMERICAN ARTS

FLORENCE M. HAWLEY, ARIZONA STATE MUSEUM, UNIVERSITY OF ARIZONA, TUCSON, ARIZONA

Simple chemistry, as a result of long observation rather than as a science, was of considerable importance to primitive people who employed it in the production of their arts. Pottery of prehistoric America illustrates a practical comprehension of the selection and preparation of clays and tempering material that, under their crude firing, would produce shapely water-proof vessels. Even more exact knowledge is postulated by the use of mineral paints in decoration, for many of these change color in firing. Certain plant juices were used in combination with hematite to produce a certain black pigment. Through chemical tests we can distinguish several types of black paints which prove to be characteristic of definite areas and of aid to the archaeologist in locating pieces of pottery.

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The importance of chemistry in the advances made toward the material comfort and progress of our modern civilization has almost obscured the part played by that science in the development of primitive man. The prehistoric nomad was compelled to roam over a large territory to obtain his food of nuts, berries, and game. He developed the art of basketry, but he knew nothing of pottery. He could not have used clay vessels had he discovered how to make them, for fragile pottery will not endure extensive transportation.

Increase in population and the consequent decrease of area over which an individual might hunt his food was probably responsible for the beginning of agriculture. Agriculture, in turn, was directly responsible for the sedentary life adopted at that period and for the development, first, of pottery; next, of organized community life necessary for the control of irrigation systems and for the direction of people gathered together in villages; and, finally, of certain other arts, crafts, and sciences. The farmer built his crude shelter and storehouses at the edge of his field, and from the clay in his dooryard the women of his family learned to make pottery. The germ of the idea must have slowly made its way into the mind of some individual who idly rolled a ball of clay between her hands and then pushed her thumb into the center to form a depression. Yet we must concede genius to that one who saw practical possibilities in the lump of clay with the hollow center, for how many others had idly pushed their thumbs into balls of clay and seen no more! Progress in the art of ceramics was undoubtedly slow; many generations must have passed before it was discovered that the clay vessel could be fired and so made impervious to water. Hand-modeled vessels were crude in shape, but eventually the women found that the clay could be rolled into ropes or fillets, which when coiled upon themselves and pressed tightly together, would form a vessel of symmetry and beauty.

Origin of Ceramics

Pottery in the Pueblo area of the southwestern United States may have been an indigenous art, or it may have developed here after the first idea had filtered up from the civilizations of Mexico where pottery had been made even at a considerably earlier period. We cannot give the exact age of the art in the Pueblo area, but we do know that it shortly followed the introduction of sedentary life based upon the cultivation of corn, a plant which had previously been brought up from Mexico or from Central America. The culture was neolithic, although later in date than that period of culture on the European continent.

Primitive woman, of course, knew nothing of chemistry when she selected a certain clay for the pottery paste and another, or perhaps a vegetable extract, for the paint with which to decorate the vessel. Through accident and experiment she learned the type of material she must use to obtain certain desired results, and through the same trial-and-error method she learned the preparation of her materials. Nevertheless, she utilized her knowledge of the properties of substances in the manufacture of articles of beauty and utility. There were many chances of variation within the range of the possible material, and the differences in composition of clays coming from various regions led to the individuality of pottery characteristic of any single area. The imprint of the individual potter never disappears from the potsherd, but that does not obscure the characteristic general style of a people or a period. And just as chemistry was used, although unwittingly, in the manufacture, decoration, and firing of pottery, so through chemistry can we now discover something of the details of its manufacture and of the extent of influence of the people who made it. The presence of the modern Pueblo Indians, descendants of the prehistoric people, offers opportunity for study of their primitive methods of pottery manufacture, methods that must closely resemble those of their ancestors.

Materials Used in Pottery

Baskets had been made and used in the southwest for some time before pottery was made, and it is possible that clay used as lining for parching baskets may have baked and broken away from the basket in a bowl shaped crust which might have suggested the making of unbaked clay vessels.

The early types of true fired pottery in Arizona and New Mexico are of gray or white paste. Clay, composed chiefly of silica and alumina, combined with water to form a hydrated silicate of aluminum, originally coming from decomposed granite or feldspar and deposited in beds by running water, also commonly contains mica, soda, potash, lime, and iron oxides.

Kaolinite, the common white clay, is comparatively free from iron oxides. Although originally light gray in color, it becomes lighter during firing in

direct proportion to the amount of carbonaceous matter, invariably present, which is oxidized at high temperature or by extended firing. Vessels to be fired were first dried in the shade to drive off slowly the excess water in order to prevent warping or cracking of the walls; they were then stacked over the coals and subjected to the heat of a fire built beneath and around them. The temperature obtained in such an open fire may have averaged from 500° to 700°C. Mineral temper, which had been added to loosen the texture of the clay, allowed the escape of the constitutional water without the clay being fused or vitrified during the hour or more of firing and so giving the vessel a bad shape and surface.

Decoration of Pottery

By the time these people had learned to fire their vessels, they had also learned to decorate them in crude and simple geometric designs, the earliest types apparently copied from those in common use upon their coiled baskets. The materials used at this time for paint may have varied somewhat according to district, as in later periods, but uncompleted studies seem to indicate that a carbon paint or vegetable extract was characteristic of much if not of all of this early ware in northern Arizona.

The custom of coating the surface to be decorated, or even of both surfaces, with a thin "slip" or wash of white clay greatly improved the appearance of vessels and made them less permeable to moisture. As the art of ceramics developed, pottery types became more specialized. Clays with greater content of iron oxides were used in areas where kaolinite clays were scarce or where more color was desired for variety. The inhabitants of the San Juan drainage in Utah, Colorado, New Mexico, and Arizona, and those of the Little Colorado and Upper Gila drainages of Arizona made black on white ware, but those of the Little Colorado area and some of those of the San Juan learned to make polychrome wares as well, using orange or red background slips. In southern Arizona the people specialized in red on buff and in the Gila polychrome ware, the black and white over a red-brown slip. In general the pottery pastes of northern Arizona (see Figure 1) were light in color, those of central Arizona somewhat darker, and those of southern Arizona (see Figure 2) distinctly brown in color. Variations of each of the pottery types show differences depending on locality and period of development.

Pastes and Pigments Used in Pottery

The chemical composition of the pastes was of great importance to the potter, for, in firing, the impurities in the clay change color, due to oxidation or dehydration, and some of the pastes would not hold the color of the designs superimposed upon them. Perhaps the most common impurities of the clay are iron oxides, which may fire to yellow, red, brown, or black,

FIGURE 1.—MIDDLE GILA AND KAYENTA POTTERY
Carbon paint was used.

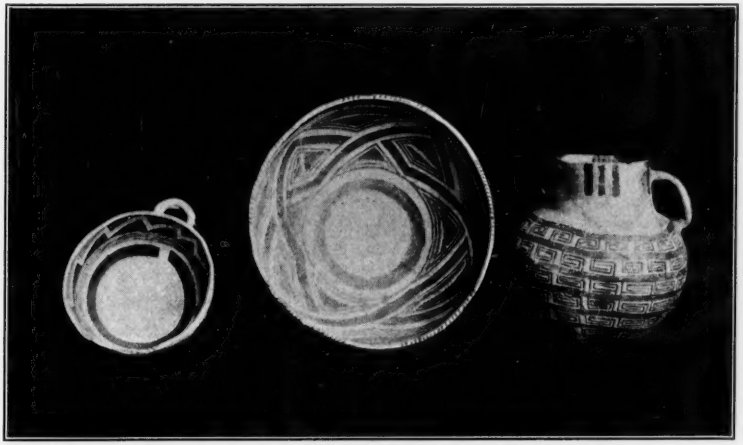


FIGURE 2.—TULARÓSA BLACK ON WHITE WARE FROM SOUTHERN ARIZONA
Black paint is of carbon and iron oxide.

depending on the kind and amount of the oxide present and the conditions under which it is fired. The clay used by the Hopi is gray in color when ground for use, but in firing it changes to a pleasing yellow, due to the presence of a small amount of yellow ochre, $2Fe_2O_3 \cdot 2H_2O$, which changes to red or orange in spots that are over-fired. Limonite is ground and mixed with water to form the slip of their red ware, the $2Fe_2O_3 \cdot 2H_2O$ losing two molecules of water in the process and so leaving the red iron oxide color. These people claim to use no red clays or pigments directly except for body paints, but other Pueblo peoples do use red slips. Orange wares, red wares, and buff wares of the prehistoric days owe their shades to varying percentages of iron oxides; the brown pastes and slips are discolored by extraneous material, such as carbonaceous matter.

Qualitative chemical tests check the ingredients of pastes, slips, and paints, but as the material from every deposit varies, such tests have seemed of little value except in definitely locating the area from which some vessels with distinctive paste came. This has been essayed with some success on the European continent but no use of it has been made in America, as colors and paints have served effectually for the same purpose. The composition of black paints, especia'ly, has been found to be so nearly constant in different areas as to serve materially as a distinguishing characteristic and thus as an indication of culture relationships.

Chemical Composition of the Black Pigments

The study of the constituents of pottery paints, especially the black, presented difficulties to the archaeologist, for analysis of the thin layer of

paint laid over the slip necessitated separation of that paint from the slip itself, or the use of some test whereby the paint could be tested while still on the vessel. Observation of the materials employed by modern Pueblo potters offered leads and checks to the chemical examination.

Pieces of pottery decorated in black were heated to redness in an open-draft electric muffle or with an oxygen torch and were kept at that temperature for from five minutes to one-half hour. Care was taken that the surface was not vitrified. It was observed that one type of black coloration burned off the surface even on short heating; the others were unaffected. This one type appeared to be carbon smudge, as was also shown by other tests for carbon. This coloration is not a true paint, but colors the entire interior surface of one type of ware through deposition of carbon or soot particles in the porous surface of the vessel during firing. Such an effect is today secured by San Ildefonso potters who fire a vessel once, take it from the fire, and cover it with smoldering manure. Prehistoric potters might have used almost any carbonaceous matter for this process. Quantitative and qualitative tests indicate that while some of the Fe_2O_3 of the red or yellow surface of the vessel is changed to Fe_3O_4 during this firing of the vessel in the reducing atmosphere, the amount changed was entirely insufficient to account for the blackness. The amount of carbon detected was sufficient.

Those sherds of pottery on which no change had been noted in black paint after heating were treated with a drop of hydrofluoric acid which was allowed to trickle across the surface. After the acid had dried, the sherds were again heated. Of these, one type showed the paint removed, a second showed the black gone but a brown stain left, and a third type showed no effect whatever.

The paint which burned off after the acid treatment was discovered to be carbon paint which had been applied as a vegetable extract, the carbon of which was protected by a thin, transparent, incipient glaze. That paint which left only the red stain after heating was evidently carbon paint to which had been added ground hematite, the type of paint used by the Zunis and Hopis today. The Guaco, or Bee plant, or a species of the Sophia is used as a basis for the modern paint. The plants are boiled in water for several hours, until only a thick dark liquid is left. The fluid is dried on corn husks and stored until needed for use, when it is dissolved in water. This used alone would produce the carbon paint; combined with enough ground hematite to thicken the solution, it produces the third type of paint.

The Hopi extract, without the added Fe_2O_3, analyzed* as follows:

* Chemical analyses given here and the methods of testing pottery paints were worked out by F. G. HAWLEY, chief chemist of the International Smelter, Miami, Arizona.

Volatile and combustible	71.5%
Ash	28.5

Partial analysis of the ash gave:

Silica	8.2%
Alumina.	4.2
Iron oxide	7.2
Lime	9.5
Magnesia	1.1
Alkalies (K_2O) and (Na_2O) . . .	32.5

Carbon dioxide combined with the alkalies and lime is also present.

Although the black color of the carbon paint is due to the carbonaceous matter, that material would all be burned away when the painted vessels were first fired if it were not for the alkali carbonates, sodium carbonate and potassium carbonate, the principal constituents of the ash, and the silica and a little soluble alkali contained in the pottery clay which is available on the surface of the vessel. These silicates and carbonates melt in the firing and form a very thin silicate film over the carbon particles of the paint, a film too thin to be called a glaze and invisible, but which protects the carbon from coming in contact with oxygen and so being consumed. If the vessel is not kept surrounded with burning fuel, producing a reducing atmosphere during the time in which the film is being formed over and around the carbon particles, the carbonaceous matter burns out before it has been covered. Occasionally the carbon of the third type of paint will slowly burn off when oxygen diffuses through the film; this leaves the paint reddish brown in color, for when the carbon is gone, the ground hematite is visible. The film of fusible silicates aids in sintering the carbon of the carbon-and-iron paint to the slip and so prevents its washing or rubbing off the vessel. Red iron oxide slips also contain silica and alkalies and so sinter to the clay wall of the vessel in firing, but white paint, which contains only a trace of alkalies, is sometimes easily removable from the surface of red vessels.

Chemical tests for manganese oxides showed that these were the main constituents of the fourth type of black color. The oxides were probably obtained from marshy places where such oxides accumulate. Being black in original appearance, it might well have suggested itself to the people as pottery paint. Some iron oxide is usually present.

True glazes, green and black, were used in the late prehistoric but pre-Columbian period in the White Mountain district of the Little Colorado drainage. Their period has been definitely dated through correlation of pottery types and tree ring counts from roof timbers by Dr. A. E. Douglass and E. W. Haury, of the department of astronomy, University of Arizona. Both a lead-copper glaze and a silicate glaze, which seems to have differed in little but relative proportion from the incipient glaze of the black paints,

were used, but the secret of the preparation of any glaze material has been lost by the modern descendants of these people.

Coloring Matter Employed in Other Arts

Mineral pigments seem never to have been used on basketry splints, for nature furnished cream, black, green, and brown material. In a few graves near Flagstaff, Arizona, however, remnants of baskets painted with thick clays of rich blues, reds, and yellows were found by an Arizona State Museum expedition. As the people had no wool until sheep were introduced by the Spaniards, they spun and wove their native cotton, and this yarn was sometimes colored by rubbing red clay into it. Designs on belts and sandals of yucca fiber may have been of vegetable dyes, such as the Navajos used on their rugs before the modern vogue for aniline dyes, but final investigation of such coloring matter awaits the future. The chief use of color, however, was in the production of pottery, that art which offered least limitations and most variation technically, and which provided necessary as well as artistic household receptacles.

THE LIFE LAYER OF THE WORLD. R. R. MCKIBBIN. A CORRECTION

On page 1998 of the September, 1930, JOURNAL OF CHEMICAL EDUCATION there is a photograph with the following inscription beneath it:

> THE PAPER OR CANOE BIRCH (*Betula papyracea Ait.*) VERY COMMONLY OCCURS ON PODZOL SOILS

This inscription should read:

> THE WHITE OR GREY BIRCH (*Betula populifolia*) VERY COMMONLY OCCURS ON PODZOL SOILS

Boiling Mercury to Replace Electric Motors in New Refrigerating Method. Boiling mercury will take the place of electric motors and pumps in home refrigerators if a new method just announced in Boston comes into general use. The new process is the invention of Dr. Daniel F. Comstock, president of Comstock and West, and one of the inventors of the Technicolor process of motion pictures in color, and Lyman F. Whitney of the firm's technical staff.

The machine is called a stator, because all moving machinery has been eliminated. Instead a small boiler contains mercury, and when it is heated and the mercury boils, the vapor is discharged into a venturi tube, sucking water vapor from the cooling unit and compressing it. Under the reduced pressure the remaining water rapidly evaporates, with resultant cooling. The heavy mercury flows back into the boiler and as it does so it pumps the water from the condensed water vapor back to its original height.

Models made so far are operated by gas, but it is stated that an electrically operated unit is contemplated. Besides ordinary uses in home refrigeration, it is stated, the simplicity of the machine will make it available for a home-cooling system, to bring low temperatures inexpensively to homes in even the hottest weather.—*Science Service*

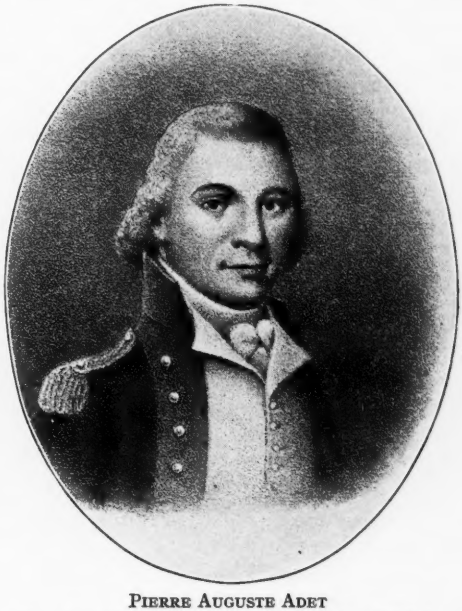
PIERRE AUGUSTE ADET*

LYMAN C. NEWELL, BOSTON UNIVERSITY, BOSTON, MASSACHUSETTS

Priestley's persistent espousal of the phlogiston theory was continued after he came to America. In 1796 he published the first of a series of four pamphlets. The fallacy of his arguments was promptly exposed by the French chemist Adet who at that time was the French Ambassador to the United States.

. . . . . .

The young American republic was promptly recognized by the young French republic. Representatives were sent by one to the other. The fifth of the French representatives was Pierre Auguste Adet. He came to Philadelphia in June, 1795. Like his immediate predecessor, Genet, he was an ardent Frenchman, still imbued with revolutionary ideas of action or at least revolutionary methods of diplomacy. Unlike Genet he was not fantastic in his views; indeed he might be classified as a member of the intermediate class, bidding the excesses of the French Revolution adieu with one hand and welcoming the orderly procedure of the new republic with the other. His intercourse and his controversies, private as well as public, even his dress, show this dual relation.



PIERRE AUGUSTE ADET
French ambassador to the United States, 1795–6.

Adet differed from all his predecessors in one significant respect. He was a chemist. And it is with Adet the chemist, not the diplomat, we are at present concerned. Definite references to him and his work are few. Undoubtedly, he shared the responsibility of the younger contingency of chemists during the early days of the French Revolution because by 1787 he had assimilated Lavoisier's fundamental work on the overthrow of the phlogiston theory and was definitely aligned with Lavoisier, Fourcroy, de

* Read at the seventy-second meeting of the American Chemical Society, September 6–11, 1926, Philadelphia, Penna.

Morveau, and Berthollet, and more specifically with Hassenfratz. These two chemists, Hassenfratz and Adet, must have become early converts to the views of Lavoisier, because they had already worked out a fairly complete system of chemical symbols for representing the new chemistry—*la chimie française*. Their system was described in two papers published early in 1787 (*Mémoires sur de nouveaux Caractères à employer en Chimie*), and was regarded by Lavoisier and his associates as so essential to the new chemistry that it was appended to that memorable book, "*Méthode de Nomenclature Chimique proposée par Mm. de Morveau, Lavoisier, Berthollet, et de Fourcroy*," which appeared late in 1787.

The symbols devised by Hassenfratz and Adet were geometrical, and were constructed of straight lines, semicircles, circles, and in some cases arcs. Each simple substance was assigned a symbol, making fifty-four in all. Straight lines and semicircles were used for non-metallic simple substances and circles enclosing the initial letters of their names were used for metals. Thus, — stood for oxygen, ⌣ for sulfur,) for hydrogen, ⌒ for phosphorus, (N) for nickel and (P) for lead. Symbols for compounds were intended to indicate the nature, number, and relative quantities of their simple components. Thus, (P) represented lead phosphide and ⌒) hydrogen sulfide. Other geometrical combinations represented an acid radical, an alkali, a gas, a liquid, an excess of a simple substance in a compound. Relative quantities in a compound were indicated by different positions of one of the elements.

Lavoisier, Berthollet, and de Fourcroy in their report to the French Academy of Sciences on this system of Hassenfratz and Adet, praised the system because it brought facts before the eye, gave correct ideas of the composition of compounds, and established a rule for writing the symbols of new compounds.

The geometrical symbols of Hassenfratz and Adet, like those of the alchemists who preceded, and of John Dalton who followed, were completely superseded by the symbols introduced by Berzelius about 1814. Nevertheless, Adet and his associate deserve credit for devising a system of symbols which supplemented the contemporary system of nomenclature. In his writings Adet used Lavoisier's system of naming elements and compounds, and as a chemist he was a staunch advocate of the new chemistry, thereby rendering great service to chemistry in America and elsewhere.

The literature contains only a few references to Adet's experimental work, the most important being a paper on the liquor of Libavius (*1*).

As stated above, Adet came to Philadelphia in June, 1795, about a year after Priestley arrived in America. In 1796 Priestley published the first of a series of four pamphlets on phlogiston and the decomposition of water.

These pamphlets are accurately described and fully discussed in a paper by Dr. Tenney L. Davis (*2*) and need not be considered here. We need only note that Priestley adhered firmly to the doctrine of phlogiston and asserted that his experiments showed that water is a simple substance, not a compound of hydrogen and oxygen. A controversy was immediately precipitated, which lasted about seven years. Two opponents of Priestley entered the field at once: John Maclean (*3*), professor of chemistry at Princeton University, and Pierre Auguste Adet.

The 1796 pamphlet was addressed:

> To Messrs. Berthollet, de la Place, Monge, Morveau, Fourcroy, and Hassenfratz, the surviving answerers of Mr. Kirwan,. . . . and I request the favour of an answer to my objections.

Answers came quickly. The first was from Adet, whose name strangely enough had not been included among those from whom Priestley requested "the favour of an answer." Adet must have obtained very early a copy of the pamphlet because he translated it into French and published the translation with his response in 1797 as a pamphlet of 96 pages, the title page of which is shown on page 46.

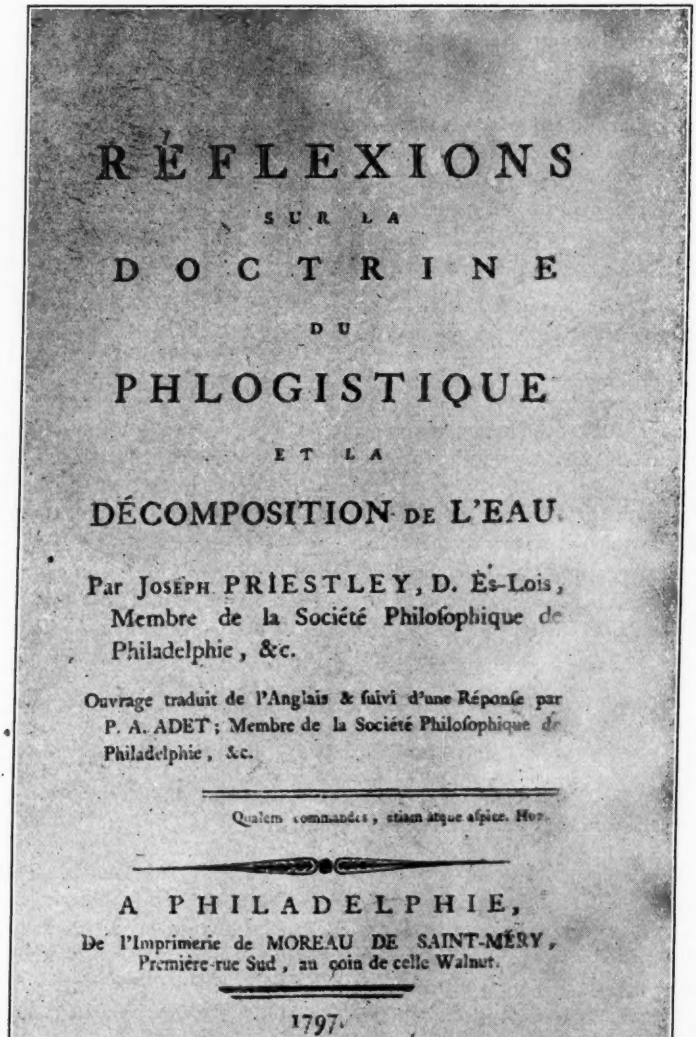
Priestley's first pamphlet appeared soon after Maclean began his work at Princeton. The pamphlet was reviewed by Maclean, in "Two Lectures on Combustion Supplementary to a Course of Lectures." This review by Maclean was published, and with the following advertisement prefixed:

> Owing to other engagements a part only of the first of these lectures was read to the students. They are now printed to save the young gentlemen the trouble of transcribing them.
>
> P.S. *It was not till after they were sent to the press* that I was informed Mr. Adet had published an answer to Dr. Priestley's pamphlet.

Adet's pamphlet was published about a week before Maclean's. Samuel L. Mitchell (*4*), professor of chemistry in King's College (later Columbia University) and editor of the *Medical Repository*, entered the controversy and opened the pages of his journal to the participants. James Woodhouse also joined the controversy and argued for a time on both sides of the question, though he finally took his stand against phlogiston on the firm ground of experiment.

Adet's response was not only prompt, but sharp, logical, and adequate. It was confined chiefly to the second part of the question; *viz.*, the decomposition of water, though of course the two parts were interwoven. This form of attack was wise because it could be based on facts recently obtained by simple experiments.

After expressing his amazement that any one acquainted with the experi-



RÉFLEXIONS

SUR LA

DOCTRINE

DU

PHLOGISTIQUE

ET LA

DÉCOMPOSITION DE L'EAU.

Par JOSEPH PRIESTLEY, D. Ès-Lois, Membre de la Société Philosophique de Philadelphie, &c.

Ouvrage traduit de l'Anglais & suivi d'une Réponse par P. A. ADET; Membre de la Société Philosophique de Philadelphie, &c.

Qualem commendes, etiam atque etiam specta. Hor.

A PHILADELPHIE,

De l'Imprimerie de MOREAU DE SAINT-MÉRY, Première-rue Sud, au coin de celle Walnut.

1797.

TITLE PAGE OF ADET'S TRANSLATION OF ONE OF PRIESTLEY'S PAMPHLETS ON THE PHLOGISTON THEORY AND OF HIS ANSWER TO THE AUTHOR

mental results should still persist in denying that water could be decomposed, Adet says he felt driven to state once again:

(1) That in causing water to pass through a red-hot gun barrel, the iron becomes oxydated by the oxygen of the water; (2) notwithstanding the difference which exists between the black oxyd of iron, produced by the decomposition of water, and the common red oxyd of the same metal, they are still both of them oxyds, for these reasons: that, like other oxyds, they both dissolve in acids without disengaging anything, and metallic bodies are incapable of combining with acids unless they are previously united to oxygen; (3) although there is some difference between this oxyd and the common red oxyd, it does not follow that they are not both oxyds; the difference between the two being only owing to the different circumstances under which they have combined with oxygen.

In general Adet asserted that Priestley's objections to the compound nature of water could be explained without the phlogiston idea.

The participation of Adet in this discussion was regarded by most American and European chemists as a determining factor, and his arguments alone, so they thought, would have convinced the most skeptical phlogistonist. But Priestley was tenacious and obdurate. In the fourth and last pamphlet (1803–4) he reprints his letter to the French chemists and says also (among other things).

On the opening of this controversy I told Mr. Adet that I should have greater pride in acknowledging myself convinced, if I saw reason to be, than in victory, and should surrender my arms with pleasure. I was sincere in that declaration; and certainly the conquest of a man's prejudice is more honourable to him than the discovery, or the most successful defence, of truth. This, however, I must, for the present, at least, decline, and leave it to you; contenting myself with the inferior praise of confirming the hypothesis for which I have contended. If, from the politeness habitual to Frenchmen, you should decline this honour, thinking my claim better founded to it than yours, I may hereafter be induced to receive it; but for the present, yielding to you a palm more glorious than that of any victory, and trusting that your political revolution may be more stable than this chemical one, I am, with greatest respect, Gentlemen, Your fellow citizen, Joseph Priestley. Northumberland in America, Oct. 22, 1803.

Adet's response, as given above, was his only written contribution to the phlogiston-water controversy. For on Nov. 25, 1796, Adet issued a note saying,

Citizen P. A. Adet informs his fellow citizens that by order of the Executive Directory, he has today notified the Secretary of State the suspension of the functions of the Minister Plenipotentiary of the French Republic to the United States of America.

The activities of Adet the politician are so fully recorded in official papers and other documents of the period that they need not be considered in a paper dealing with Adet the chemist. After leaving the United States he held other diplomatic and semi-official posts under the French government. However, he retained his interest in chemistry and in 1804 issued a book entitled "*Leçons Elémentaire de Chimie.*" Adet died in 1832.

Literature Cited

(1) LIBAVIUS, "Sur le muriate d'étain fumant ou Liqueur de Libavius," *Ann. chim.*, **1**, 5 (1794).
(2) DAVIS, "Priestley's Last Defense of Phlogiston," J. CHEM. EDUC., **4**, 176–83 (Feb., 1927).
(3) FOSTER, "Doctor Maclean and the Doctrine of Phlogiston," *ibid.*, **2**, 743–7 (Sept., 1925).
(4) HALL, "A Chemist of a Century Ago," *ibid.*, **5**, 250, 253–7 (Mar., 1928).

Radium Decay. Fears aroused by the experiments of one L. Bogojavlensky, indicating that the rate at which radium and allied substances decay into other elements may be made to change, have been allayed. For Madame Curie, who with her husband, Pierre, in 1902, discovered radium, has said she is unable to find any evidence to indicate that such change is possible.

In short, radium is going along decaying at the same old rate, 1750 years for half a given quantity. It is the custom of scientists in expressing the disintegration of the elements of the radioactive series of uranium to speak in terms of the half period, or the time required for the disintegration of half a given amount. And in this respect it is interesting to note that the time required for the change in the elements concerned varies from one-millionth of a second to eternity.

Out of the work of the distinguished English scientist, Soddy, one-time member of the staff of McGill University in Montreal, has come understanding of the disintegration of the radioactive elements. When, for instance, radium emits helium there is produced another gas, radium emanation or radon. The latter, radioactive in its own right, undergoes still further disintegration. So radium, it seems, occupies an intermediate niche in a long series which begins with uranium and ends with lead. The latest market quotation on radium is $65,000 a gram.—*Tech. Rev.*, **32**, 362 (May, 1930)

Lithium. Quantity production of lithium in America seems assured. Lithium, it will be recalled, is a metal whose specific gravity is less than that of water; a chunk of it dropped upon water will float like cork until it disintegrates. Although recently produced commercially in Europe, it is still very rare in this country and has been selling for more than $200 a pound. The new quantity production method developed by Dr. H. M. Partridge, assistant professor of chemistry at New York University, made it possible to place it on the market in ton lots at $15 a pound.

Lithium is used in alloys and it loses its softness when combined with some other metals. It has been used to obtain a better tone in bells and its sponge-like absorption of gaseous impurities has made possible the increase of lifting power of helium gas by some fifteen per cent. The American product, according to Dr. W. C. MacTavish, who announced its development at the New York Electrical Society, is much purer than the German, although its production is based upon German patents plus methods devised by the University of New Hampshire five years ago by the late Professor Charles James and Dr. McTavish.—*Tech. Rev.*, **32**, 147 (Jan., 1930)

LEADERSHIP*

ARTHUR D. LITTLE, ARTHUR D. LITTLE, INC., CAMBRIDGE, MASSACHUSETTS

Leadership which one can trust has always been the supreme necessity of mankind.

While the contributions of leaders in science have been beyond estimate in monetary terms, they have been of even more importance in the realm of ideas and spiritual things.

In its highest manifestations leadership in science is the integrated expression of many exceptional qualities: acute power of observation, concentration, imagination which must be both vivid and controlled, intellectual honesty. Leadership itself is an attainment rather than a gift, and all normal men are potential leaders, but leadership is contingent on the willingness to accept responsibility and to pay the price of leadership, which may involve ridicule, self-sacrifice, hard, and continuous work.

Numerous illustrations from the lives of leaders in science are given.

. . . . . .

In the crises of human thought and action the world instinctively searches for leaders: for those exceptional personalities whose qualities of mind and heart compel allegiance; who willingly accept responsibility, and who can, if necessary, enforce obedience. The history of the rise and fall of empires, of the migrations of peoples, and of the spread of dogmas is, in largest part, the story of these personalities and of their reaction upon their times. Leadership which one can trust has always been the supreme necessity of mankind.

True leadership is necessarily rare, and it is among the most precious assets of humanity. In Italy, Napoleon said: "Good God! How scarce men are! There are thirteen million in Italy, and I have, with difficulty, found two, Dandolo and Metzi." And he again voiced his appraisal of leadership by saying, during the Russian campaign, "I have two hundred millions in my coffers, and I would give them all for Ney."

It was of a leader in science that President Hoover once said, "Our banking community does not do the public service in a year that Faraday's discoveries do us daily."

The contributions of Pasteur to human welfare are beyond estimate in monetary terms, but the direct financial value of his discoveries to France alone was years ago appraised by Huxley as sufficient to cover the whole of the war indemnity paid by France to Germany in 1870.

If such are the pecuniary values of leadership in its relation to material things and large affairs how vastly more important is it in the realm of ideas and spiritual things. How far beyond evaluation are the contributions of Socrates, Plato, Confucius, Buddha, and Christ! How devastating have

* Dohme lecture, The Johns Hopkins University, November 7, 1930.

been those of Marx and Lenin! Ideas are greater than men, and they are far longer lived. The great leader identifies himself with great ideas.

But our thoughts today are concerned, primarily, with leadership in science, and, still more specifically, with leadership in chemistry. We have in mind that Fifth Estate, the members of which I once defined as "those having the simplicity to wonder, the ability to question, the power to generalize, the capacity to apply."

The Johns Hopkins University has always stood for leadership. When Daniel C. Gilman, its organizer and first president, sought to give effective expression to the generosity of its founder, he did not attempt to do so in bricks and mortar. Instead, he hunted the world for men who were leaders in their professions, and he housed them as he could.

True to its traditions the University is now carrying into effect a plan of especial promise and significance which has for its purpose the selection and education of potential leaders in the field of chemistry.

Chemistry and physics constitute the closely woven cord by which the several sciences are bound together in an authoritative whole, like the assembled rods of the Roman fasces. They are the fundamental sciences, but chemistry is even more specifically concerned than physics with those changes to which matter is subject and upon which all human activities, and all life itself, depend. The field of chemistry includes the whole material universe, and its contributions enrich all other sciences and arts. Especially is this true of those departments of knowledge which most directly promote the welfare and progress of mankind. Within a few recent decades chemistry has greatly increased the yields of agriculture; revolutionized mining by new explosives and vastly more efficient means for the recovery of values from the ore; it has provided engineering with better materials of construction; supplied industry with innumerable new processes and products; extended the range and facility of transportation and communication; and, in countless ways, multiplied the comforts and increased the amenities of life. By its contributions to medicine and sanitation the health of millions has been conserved and protected, while through the reaction of chemistry upon astronomy and other sciences fresh vistas have been opened to the mind.

The world is thus, already, heavily in debt to those leaders in chemistry whose research and vision have blazed the way to these conspicuous benefits, and the hope of the world for further progress and deeper insight must, in large part, find its justification in those new leaders in that science for whom we confidently look.

In its highest manifestations leadership in science is the integrated expression of many exceptional qualities. There is that acute power of observation which led Sir Henry Bessemer to note that a blast of air had burned out the carbon in the cast-iron bar with which a hole in his furnace

had been plugged. There is the ability to detect, and to reason from, what seem to be minor abnormalities, as when the difference in the atomic weight of the ordinary lead and that of lead associated with uranium in the ore caused Soddy to declare his belief in the existence of isotopes. Because they could generalize from great groups of patiently segregated facts we have Dalton's atomic theory and the periodic table of Mendeléeff. One does not come to such results without great power of concentration, and we find it again supremely evident in Moseley, who gave us the Law of Atomic Numbers.

Closely associated with these qualities, if not, indeed, the parent of them, is imagination, which, to serve its highest purpose, must be both vivid and controlled. It is the precious endowment of those whose mental vision pierces the veil of the unseen. Kekulé brooded upon the carbon chain until, as he sat before the fire, the serpent switched and caught its tail within its mouth, and the great conception of the benzol ring was born. Imagination enabled the Braggs to look within the crystal to the spacing of the atoms, and it disclosed to J. J. Thomson, Gilbert Lewis, Langmuir, Rutherford, and Bohr the complex and marvelously ordered systems which are the atoms themselves. The imagination of the scientist has much in common with the imagination of the poet, although, unlike the poet, the scientist is first born, then made. But imagination, whether of poet or scientist, demands raw material upon which to work and, for the scientist, this raw material is facts. These must first be patiently accumulated, however unrelated they may seem to be. Then follows their long blending and incubation in the subconscious mind. Finally, from some external source, comes the catalytic suggestion which, in a flash of insight, transforms and transfigures what was before inchoate and obscure.

As a ballast to imagination there must be that intellectual honesty which prevents you from fooling yourself about yourself, and which does not permit you to believe merely because you wish to believe.

The quality of leadership is an endogenous growth. "Victory," the Buddhists truly tell us, "comes from within," and in the words of Emerson, "Self-trust is the first secret of success." So there must be confidence in yourself and in the children of your brain; the courage to accept responsibility and to act upon matured conclusions; the willingness to pay the price of leadership, though it may include ridicule, self-sacrifice, and hard, continuous work. The maxim which held Darwin to his great task was "It's dogged as does it."

Finally, there should always be a definite goal toward which all effort is directed. We may never reach the goal, but we shall certainly go farther than he who is sauntering without one; and, since there is much truth in Stevenson's conclusion that "It is better to travel hopefully than to arrive," we shall be fortunate if our goal is one which constantly advances as we proceed.

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Although alert to seize opportunity when it presents itself, leaders do not wait supinely for its arrival. They go out to meet it at the cross-roads, and they create it, if it is not there. Faraday, who seemed condemned to spend his life in binding books, attended a lecture by Sir Humphry Davy, at which many other young men were, doubtless, present. But Faraday, alone, prepared so accurate a report of what he had heard that upon its submission to Sir Humphry he was engaged as his assistant, and a great career of leadership began. It was a career involving many sacrifices, for he said, "I cannot afford to get rich." We may learn much of the cost of leadership from other careers which, like that of Faraday, are sources of inspiration.

Arrhenius, like a viking of truth, battled for years to establish his theory of electrolytic dissociation. Avogadro, though ignored during a long lifetime by his fellow-chemists, was so serenely conscious of the truth of his great generalization that he continued to teach his students that "equal volumes of all gases under the same conditions of temperature and pressure contain the same number of molecules." When stereochemistry was born with the publication of van't Hoff's "Chemistry in Space," its author met with imperturbable good nature the storm of ridicule and sarcasm which his views aroused. He worked and waited until they found acceptance. There are vested interests in old ideas as there are in material things, and intruders are resented in the one case as in the other. So, in the words of Emerson, "If God has called any of you to explore truth and beauty, be bold, be firm, be true." Then can you say with Browning in "Paracelsus:"

> "I press God's lamp
> Close to my breast; its splendor, soon or late,
> Will pierce the gloom: I shall emerge one day."

The price of leadership is billed in many coins. It may be paid, as it was by Madame Curie, in aching years of poverty; years lived in a garret room on one-half franc a day, thinking long thoughts and carrying coal and water up five long flights of stairs.

Often the price has been the dogged courage which holds the leader to his course in spite of physical limitations and disabilities which might well crush another. Roosevelt, the exponent of the strenuous life, was a weak and sickly child, but he made himself a man; the sort of man whose own experience permitted him to say, "Never yet was worthy adventure worthily carried through by the man who put his own personal safety first." Pasteur, early in his career, was the victim of a paralytic stroke which would have broken a weaker spirit. Instead, it spurred Pasteur to greater effort, which resulted in much of his best work. Mendeléeff, whose dying mother said to him, "Refrain from illusions, insist on work and not on

words," had hardly passed his twentieth year when the physician who examined his weak lungs gave him only six months to live. Undaunted, he lived on for more than fifty years and developed his monumental periodic table.

But leadership connotes that there are those waiting to be led, and to lead men you must learn to know them. Moreover, it will avail you little, if, having a message of light and leading to deliver, you have not trained yourself to present facts, arguments, and conclusions clearly, and so to defend them as to ensure acceptance.

The great laboratory leaders have always been distinguished for their power of stimulating originality in others. The influence of Ira Remsen pervaded The Johns Hopkins laboratories, and his books and Remsen's *Journal* carried that influence far afield. He led one student to the discovery of saccharin. He developed leadership in others as evidenced by many of the names appearing with his own in the list of fifty-eight papers of which he was co-author.

The contagious enthusiasm of Whitney, who does not wish to go to heaven if there are no problems there, has been the cement and inspiration of a great research staff. J. J. Thomson, who, at twenty-eight, succeeded Lord Rayleigh as director of the Cavendish Laboratory, advanced its great reputation not only by his genius as an experimental physicist, but even more surely by his intensely human qualities, which immersed his assistants "in an atmosphere sparkling with new thought." Of his pupil, Rutherford, who for ten years shed luster upon McGill University and later succeeded his master at Cambridge, it is said: "He is a man resembling the alpha particle in his local concentration of energy. He is inimical to leisure. He can arouse enthusiasm in anything short of a cow or a cabinet minister. Frank and genial, he can discuss almost any subject and smoke almost any tobacco."

Fortunately, since there are few who can aspire to become a Langmuir, a Thomson, a Rutherford, or a Willard Gibbs, the average man, by whom most of the world's work is done, looks for his immediate leadership to those whose mental equipment is only measurably greater than his own. For every general there must be many captains, and for the guidance of the rank and file it is commonly the sergeants who are most useful. Since, therefore, there is thus place and scope for leadership of many grades it is inspiring to realize that some of its essential qualities are present, even though latent, in most of us. So good a judge of leaders as Owen D. Young says, "Basically, I think, nearly all normal men are potential leaders," and he says again, "There's nothing magical about leadership, but there are certain penalties attached to it," and he concludes that ninety-nine out of one hundred potential leaders fail to take their proper place because of their unwillingness to accept responsibility and to pay the price of leader-

ship. Or, as Arnold Bennett boldly puts it, "the majority do not desire success . . . the average man flourishes and finds his ease in an atmosphere of peaceful routine."

For those who are willing to pay the price there is encouragement in these words of Emerson: "The habit of directing large affairs generates a nobility of thought in every mind of average ability. For affairs themselves show the way in which they should be handled, and a good head soon grows wise."

Leadership is accorded naturally to those who have acquired an authoritative mastery of some branch of knowledge, and who have developed those personal qualities which command respect and make for happy human relations. Or, as Mr. Ivy Lee puts it: "If one immerses himself in a given subject until he has mastered it, if he has a vision which enables him to see beyond the present, he becomes, sooner or later, to those who know him, a comfortable sort of person to go to for advice or reinforcement."

Although the grade of leadership which one may reach is largely determined by circumstance and endowment, leadership itself is an attainment rather than a gift.

In endowing the Chair of Chemical Education at The Johns Hopkins, Mr. Francis P. Garvan, to whom chemistry is otherwise deeply indebted for many benefactions, stipulated only that the work of this professorship be initiated and promoted for the advancement of that science. But chemistry has, already, workers in plenty for the cultivation of its bounded fields, while, for the conquest of the vast territory beyond these landmarks it must first rely upon the leadership of pioneers.

Having in mind the objective defined by Mr. Garvan, the authorities of the University have developed and inaugurated a plan, already national and ultimately international in scope, for the selection and training of potential pioneers in chemistry.

The details of the plan itself, the exacting care demanded in the selection of its beneficiaries, and the very generous provision for their maintenance are familiar to you all. Every friend of chemistry and each member of that vast community to which chemistry brings enlightenment and service is under heavy obligation to those donors whose vision and liberality have made possible the realization of the plan. Happily some of them are here today, but it is particularly to you whose promise has led to your selection as students under the plan that I address myself.

You have been selected because it is confidently believed that the qualities of leadership which we have been considering are latent in each one of you. How far they find expression in your individual careers is much more definitely in your own hands than in those of your instructors. Yours is the opportunity. May you utilize it to your own high honor and satisfaction and to the enduring benefit of the world.

AN AMMONIA WORLD*

W. Conard Fernelius, The Ohio State University, Columbus, Ohio

Water is both the most familiar and the most abundant chemical compound on the earth. Probably there is no single factor which so much influences the activities of the inhabitants of this planet as does water. This important position occupied by water may have resulted by mere chance and there might well be another world where a different solvent occurs in an abundance equal to that of the water of this earth. An "ammonia world" where liquid ammonia replaces the water of this planet would have many characteristics common to a "water world" but would also differ greatly in many respects.

. . . . . .

Suppose for the moment that the water on our earth were to be replaced by some other liquid such as ammonia. How would such an exchange alter our familiar surroundings? This is a question which Professor E. C. Franklin of Stanford University seeks to answer when each year, at the conclusion of his course on "The Ammonia System of Compounds," he devotes the final lecture to a discussion of an imaginary world where ammonia functions in the capacity of the water on our planet. For the benefit of the readers of the Journal of Chemical Education, the writer will attempt to set down the substance of this lecture with the same spirit as he heard it given by Professor Franklin.

This World One of Water

To us on this earth, water is at once the most familiar and most important of all substances. It might be said with much justification that the world as we know it is largely a "water" world. The very abundance of water stands witness to the truth of this statement. The oceans make up about three-fourths of the total extent of the earth's surface; moreover, they contain an amount of water sufficient, if the earth were a perfect sphere, to cover the entire area to a depth of between two and three miles; likewise water is of very general occurrence upon the land, not only in lakes and streams, but also in the soil. The atmosphere also contains an abundance of water both as aqueous vapor and as clouds. Probably no single factor is so much responsible for our climate as is water. In molding the earth's surface, water rivals and perhaps even surpasses heat as the biggest factor in geological evolution. Even minerals are built up in a large measure of water- or aquo-acids (oxygen-acids), as well as of water of composition. Physiologically, the compound water makes up from seventy to ninety-five per cent of the animal and vegetable body (about seventy per

* Throughout this paper reference will be made to the ammonia system of compounds and the properties of liquid ammonia. The reader is referred to a series of articles by Johnson and Fernelius entitled "Liquid Ammonia as a Solvent and the Ammonia System of Compounds," J. Chem. Educ., **5**, 664, 828 (1928); **6**, 20, 441 (1929); **7**, 981, 1291, 1602, 1850, 2600 (1930).

cent in the case of the human body) and all of the life processes take place in aqueous media. Small wonder is it then that the physicist has chosen water to define his standards of density, of heat capacity, etc., and as a means to obtain fixed points in thermometry. Likewise it is hardly surprising that our chemistry has been largely a "water" chemistry; *i. e.*, a study of aqueous solutions and of substances having an intimate relationship to water such as the oxygen salts, etc.

Possibilities of an Ammonia World

With the vast number of astronomical bodies now known in the universe and many others as yet unknown, there seems to be no reason why it should be assumed that all planets have approximately the same composition as our earth. Rather it might seem more logical to assume that our world has, through the special conditions of its origin, come down to us as we know it. It does not seem at all improbable that another planet originating in another part of the universe might be made up of the same elements, to be sure, as our own earth but in considerably different proportions.* For the sake of the present discussion, let us assume the possibility that somewhere in space there is a planet not greatly unlike our own revolving about some unknown sun. It differs from our own earth, however, in that instead of a great predominance of oxygen as on the earth there is an equally great predominance of nitrogen on our imaginary planet, and that the compound water so common in our world has been replaced by the hydride of nitrogen, ammonia. In short let us assume the possibility of an "ammonia" world and examine such a world to see how it would differ from our own.

Properties of Water and Ammonia

One might be surprised at first to find that in many characteristics an ammonia world would closely resemble the one which we know. If to water are to be attributed many of the outstanding characteristics of our habitat, then it is certain unusual properties of water that give it preeminence above other substances. Water is a unique substance; in many of its properties water is an extremist. Whereas the values of some of the physical constants are greater for water than for any other substance, the values of other constants are at a minimum in the case of water. The boiling point, melting point, critical temperature and pressure, specific heat, and heats of volatilization and fusion, as well as the dielectric constant and association constant have values unusually high for a substance of

* Only a consideration of the distribution of elements throughout the universe would indicate whether or not this earth represents the average distribution of the elements. The problem would be complicated by the continual synthesis and decomposition of elements that is known to be going on all the time.

such simple composition. On the other hand, the values for the boiling-point elevation and freezing-point depression constants are unusually small. As a solvent water stands out as the most universal of all solvents. Not only does it excel all other solvents in its sheer ability to dissolve so large a variety of substances, but also in its capacity for causing electrolytic dissociation—the breaking up into electrically charged ions in solution. Furthermore, water has a remarkable tendency to form compounds with salts, etc., known as hydrates, or salts with water of crystallization.

In all those properties which give to water its unique position among solvents liquid ammonia shows a remarkable similarity to water. While the boiling point of liquid ammonia is nearly 34° below zero, it still appears abnormally high when compared with the boiling temperature of phosphine, arsine, stibine, methane, ethylene, hydrogen sulfide, hydrogen chloride, etc. The specific heat of liquid ammonia and the heat of fusion of the solid are greater than the corresponding constants for water or any other known substance, while its heat of volatilization, with the one exception of water, is the highest of any known liquid. The critical temperature of ammonia is abnormally high, and its critical pressure—the more characteristic constant—is higher than that of any other liquid excepting water. Ammonia is an associated liquid, and its dielectric constant, though much below that of water, is still high when compared with that of non-electrolytic solvents. Its boiling-point elevation constant is the lowest of any known liquid, namely 3.4 as compared with 5.2 for water. In its tendency to unite with salts and other compounds, it probably exceeds water, since salts with ammonia of crystallization are perhaps even more numerously recorded in the literature than are salts with water of crystallization. As a solvent for salts, it is generally much inferior to water, though some salts, for example, the iodides and bromides of mercury, lead, and silver, dissolve very much more abundantly in ammonia than they do in water, and it far surpasses the latter solvent in its ability to dissolve the compounds of carbon. Finally it exhibits conspicuous power as an ionizing solvent, the more dilute ammonia solutions at −33.4° being very much better conductors of electricity than aqueous solutions of the same concentration, at 18° (*1*).

TABLE I

Properties of Ammonia and Water

	Liquid Ammonia	*Water*
Melting point	−77.7°	0°
Boiling point (760 mm.)	−33.35°	100°
Specific heat	1.13	1.0
Specific gravity at 20°	0.607	0.9982
Critical temperature	131°	365°
Critical pressure	112 atms.	195 atms.
Dielectric constant	22	81.7
Molal freezing-point constant	0.98	1.858
Molal boiling-point constant	0.34	0.52
Heat of vaporization (normal boiling point)	337 cal.	536 cal.
Heat of fusion	108 cal.	79.5 cal.
Specific conductivity	5×10^{-11} at −33°	4×10^{-8} at 18°
Surface tension	41.8 dynes/cm.	75 dynes/cm.
Coefficient of viscosity	0.00266 at 33.4°	0.01054 at 18°

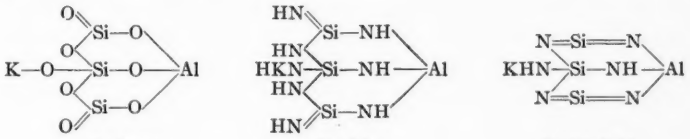
An Ammonia World

Returning to a consideration of an ammonia world, undoubtedly, we should find it to consist, like our own, of three parts: an atmosphere, a hydrosphere (ammonosphere might be more correct), and a lithosphere. The atmosphere would consist of nitrogen probably with some other gases diluting it. Ammonia would also be present, similar to the water vapor in our own atmosphere, but in an amount greater than that of water in our atmosphere, since the vapor pressure of ammonia near its melting point is considerably greater than the vapor pressure of water near its melting point. The oceans, lakes, and streams would be filled with liquid ammonia and would therefore be at a temperature between $-77°$ and $-33°$ (assuming of course that atmospheric pressure is 760 mm. of mercury). If the temperature rose above $-33°$, all of the ammonia would boil off into the atmosphere.

These ammonia oceans and lakes would show some very distinct differences from the ones on this earth. Liquid ammonia does not exhibit a maximum density a few degrees above the freezing point as does water, nor is the solid ammonia specifically lighter than the liquid at the freezing point. Hence ammonia ice would not float on the surface of streams and lakes. Nor would the ice form at the surface of a body of liquid ammonia and thus offer a protective covering to the liquid below as is familiarly known to be true in the case of water. Hence it would not be uncommon in a cold winter to find large bodies of ammonia frozen entirely solid. Thawing in the spring would be different from what it is in our world. Obviously, there would be no ice jams on the navigable rivers, since the ammonia ice does not float. Furthermore, because liquid ammonia shows no maximum density at any temperature, there would be much less circulation in large bodies of ammonia. This lack of circulation together with the low thermal conductivity of liquid ammonia would render melting a very slow process indeed. The sad picture of annihilation by the eventual freezing of all the ammonia might face the inhabitants of an ammonia world. As it cooled each winter, ammonia would continually sink to the bottom and then freeze. The ice, once formed, could not be entirely melted because the warmer ammonia would stay at the surface. Year after year the frozen ammonia would increase in winter and persist through the summer, until eventually all or much of the body of ammonia, according to the locality, would be solidified. There is no reason why the phenomena of rain, snow, fog, and dew could not be duplicated with ammonia. The flow of an ammonia glacier, however, would be greatly arrested because the ammonia ice would not melt under pressure. There would be no icebergs to worry navigators again because solid ammonia does not float on the liquid.

Turning now to the more solid portions of our imaginary planet, we might find large rock and mineral masses: ammono limestones, ammono

silicates, nitrides, etc. The limestone of our new world would be calcium cyanamide, $CaCN_2$, and the dolomite a mixed calcium magnesium cyanamide, $CaCN_2 \cdot MgCN_2$. The feldspars would be replaced by ammono feldspars such as the one below:



$KAlSi_3O_8$ $KAlH_8Si_3N_8$ $KAlH_2Si_3N_6$

THE FELDSPAR ORTHOCLASE AND ITS POSSIBLE NITROGEN ANALOGS

The kaolin of the ammonia ceramist would be an aluminum ammonosilicate like the one below:

CLAY OR KAOLIN, $Al_2Si_2O_7 \cdot 2H_2O$ AND ITS AMMONIA ANALOG

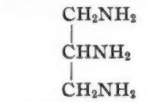
The ammono quartz would be the nitride of silicon, Si_3N_4. One might go on to work out any number of possible minerals and rocks. It is not at all inconceivable that erosion could be duplicated on such a world. However, this phenomenon would be restricted to a wearing process since freezing would be of no value in prying loose small rock fragments. We would find the pores of the soil holding liquid ammonia much as our own soil holds water in the form of surface films and in small capillaries. The high value of the surface tension of ammonia, like the even higher value for water, would be a great aid in the retention of liquid by the soil.

Turning now to sources of energy on our imaginary world, there would be the heat from the sun's radiations, the force of the winds, and the energy of falling rivers and streams. We might justly choose to call the latter "ammonia power" rather than water power.

Life in an Ammonia World

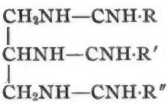
Just as scientists and others have long considered the possibility of Mars and other planets being inhabited by living creatures, so we should want to know if life would be possible on our ammonia world. There is little reason for thinking that it would not. Professor L. J. Henderson (*2*) has shown that the influence of the environment on living forms is not only to favor the most fit (Darwin's survival of the fittest), but rather, in a broader sense, that life itself is a product of its chemical and physical environment, and that life is what it is because the environment is not otherwise than

what we find it. Hence, with a different chemical environment such as would be present in an ammonia world, it seems likely that phenomena which we might justly call life would be present. However, living creatures would very likely take on forms and activities different from those of living organisms on this earth. Just what functions life in a nitrogen world would assume, one can only conjecture. Whether life there would maintain itself by the "nitridation" of carbon, as life on this planet uses the energy of oxidation of carbon compounds, we cannot say. Certainly, however, ammonia must serve such living forms as the solvent vehicle for the assimilation and circulation of foods and the elimination of wastes. Also, if the living organisms be at all complex and not living in a liquid medium, the evaporation of ammonia from the surface of the body might serve as a means for very effective regulation of the temperature of the living form. To make the idea of life on an ammonia world more vivid, one might point out that colloidal systems can and are known to exist in liquid ammonia (*3*) and that ammonia analogs of sugars, fats, etc., can easily be pictured as existing.

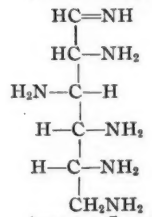


AMMONO GLYCERIN

CARBAZYLIC OR AMMONO FATTY ACID
(many examples known)

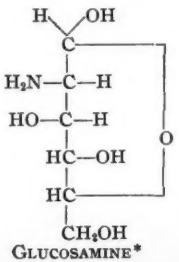


AMMONO FAT



AMMONO GLUCOSE

Indeed, certain lobsters have gone the first step in this direction, for they are capable of synthesizing glucosamine which can be obtained from the chitin of their shells.



GLUCOSAMINE*

But the life of our ammonia world inhabitants would differ vastly from our own. Reaction velocities at the temperature of their world would be slow and it might well be necessary always to have catalysts to hasten these slow reactions. There could be no cooking in such a world unless it be pressure cooking. Our familiar problem of the fixation of nitrogen would most likely be replaced by an equally difficult problem of obtaining oxygen and oxygen compounds. An "ammoniaker" chemist might exhibit with considerable pride his specimen of the little known substance, water. Freshman chemistry students in our ammonia land could not amuse themselves by throwing sodium into liquid ammonia as our own do with water. In place of the explosive reaction with water, sodium goes quietly into solution in liquid ammonia to form a deep blue solution. The materials of the ammonia world chemist would be considerably different from our familiar reagents. His bases would be the amides, imides, and nitrides of the basic metals; potassium amide, KNH_2, would be as familiar and as useful as our sodium hydroxide. Among the "acids" our imaginary chemist would probably know hydrochloric, NH_4Cl, carbonic, H_2NCN or $HNC(NH_2)_2$, nitric, HN_3, hypoiodous, H_2NI, silicic, $HNSi(NH_2)_2$, phosphoric, $(HN)_2PNH_2$, and several others. Salts would be present in abundance. The "alcohols" would be the primary and secondary amines and for beverages our ammono people would have the choice of two ethyl alcohols: ethylamine, $C_2H_5NH_2$, and diethylamine, $(C_2H_5)_2NH$. Hence, we might suppose that the duties of a prohibition officer in our ammonia land, should there be such an institution as prohibition there, would be doubly strenuous. The phenols would be the aromatic amines such as aniline, $C_6H_5NH_2$, and the ethers would be the tertiary amines, $(C_2H_5)_3N$. There would also be aldehydes and ketones, though, because of the trivalence of nitrogen, in far greater variety than among the oxygen compounds.

$C_6H_5CH{=}NH$	
$C_6H_5CH{=}NR$	$(C_6H_5)_2C{=}NH$
$C_6H_5CH{=}N$	$(C_6H_5)_2C{=}NR$
$C_6H_5CH\diagdown$	C_6H_5CN
$C_6H_5CN{=}N\diagup$	
ALDEHYDES	KETONES

Thus one might elaborate a complete chemistry for these ammonia people.

If the chemistry of the ammonia-world inhabitants would differ from our own, so should one expect their physics to present equally striking differences. Should they choose ammonia as their standard to define

* The mannosamine structure is presented here because it seems probable that glucosamine undergoes the Walden inversion on treatment with nitrous acid to prove its structure (LEVENE, "Hexosamines and Mucoproteins," Longmans, Green and Co., New York, 1925).

certain physical constants, as our scientists have chosen water, great differences would result. First, the unit of specific heat would not be the same, for 1.13 of our calories would be required to raise the temperature of one gram of ammonia one degree Centigrade. Further, the system of thermometry might well differ. The melting point of ammonia is $-77.7°$ and the boiling point $-33.35°$; calling the first temperature 0° Ammonia and the latter 100°A., then one degree on the ammonia scale of temperature would equal 0.4435 of a degree Centigrade, and 0°C. would be approximately 175°A. Finally, if the physicists on our imaginary ammonia world had chosen to define their unit of weight, an ammonia gram, as the weight of 1 milliliter of ammonia at some stated temperature—say $-40°$—then their entire system of weights would differ from our own since ammonia is much less dense than water. Ammonia, however, would be a very poor substance to serve as a standard for density because its density varies continually with temperature and does not slowly approach toward and descend from a maximum density as does water at 4°.

Such then would be some characteristics of an "ammonia world"; a world essentially similar to our own water world but differing greatly in many respects because of differences in the basic substances making up such a world. One might similarly picture a hydrogen sulfide world where the minerals are sulfur compounds and life is built around the element sulfur. Recent studies of sulfur bacteria have revealed organisms which have gone perhaps just a step in this direction.

Literature Cited

(1) FRANKLIN, *Am. Chem. J.*, **47**, 255 (1912).
(2) HENDERSON, "The Fitness of the Environment," The Macmillan Co., New York City, **1927.**
(3) TAFT, *Trans. Kan. Acad. Sci.*, **32**, 38 (1929); FRANCE, WILDER, and RANKIN, private communication.

Acrolein Makes Refrigerant Safe. The addition of acrolein, an irritating gas used in the World War, to methyl chloride when used in household refrigerators will make it impossible for a person to remain near a leak long enough to be injured by the poisonous gas, which has in the past caused several deaths. Experiments conducted by the U. S. Bureau of Mines at Washington at the request of the manufacturers of electric refrigerators and methyl chloride, indicate that one part of acrolein to a million parts of air will produce a decided irritation of the eye and nose in two minutes and will become practically unbearable within five minutes. Exposure to even a bad leak of methyl chloride for that length of time does not cause apparent harm.

Acrolein is that acrid, irritating stuff familiar to the housekeeper who has ever allowed fat to spatter on a hot stove or who has forgotten the kerosene lamp and let it burn low and smolder. In the chemical laboratory it is made from glycerin.—*Science Service*

PRESENT STATUS OF TEACHER TRAINING IN THE UNITED STATES*

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Original data used in this article were taken from a study of 741 college teachers of chemistry located in 45 states.

Of 724 college teachers, 174 have the bachelor's as their highest degree, 263 the master's, and 287 the doctor's degree.

About one-third of the teachers have had courses in professional education. The median amount is 13.3 semester hours.

Twenty-seven per cent of the teachers have had previous public school experience in teaching. The median amount is about three years.

The median salary of all ranks is $2904; of full professors, $4172.

Twenty-two per cent of the teachers report supplementary earnings. The median amount is $321 per year.

The median age of all teachers, including assistants, is 33 years; of professors, 46 years.

A great need for research on instructional problems exists.

Training equivalent to a major in chemistry is advocated.

The article discusses the teacher training agencies necessary and suggests changes in present programs. Problems of supply and demand, curricula, selection of prospective teachers, and the place of professional and of subject-matter content receive consideration.

. . . . . .

For this paper data concerning the qualifications of college teachers of chemistry were secured from question lists sent during the course of a recent nation-wide survey to approximately eight hundred teachers of chemistry. These teachers were distributed among forty-nine state-supported universities and colleges, located in forty-five states. Returns were secured from seven hundred forty-one teachers fairly well distributed through the several faculty ranks. The institutions from which returns were received range in size from the University of California to the smallest among the state colleges. It is believed the returns show fairly typical conditions in respect to the qualifications of college teachers of chemistry in this country.

Information concerning the qualifications of high-school teachers was secured from existing secondary sources including official government reports and statistics, studies made by workers in the Division of Chemical Education, and other studies.

The generalizations and conclusions concerning the present status of teacher preparation in the United States are derived from the literature of

* Contribution to the symposium on "The Qualifications of Chemistry Teachers" held by the Division of Chemical Education at the 80th meeting of the American Chemical Society, at Cincinnati, Ohio, Sept. 10, 1930.

the field, survey material, and field work. Our topic, "The Present Status of Teacher Training in the U. S.," can obviously be treated only in respect to a few outstanding problems. Those chosen are the ones that we have reason to believe are of current interest to those engaged in the preparation of teachers; they represent problems mentioned by seventy-three leading educators in response to a recent letter requesting suggestions of problems in connection with a national survey.

There are approximately one million teachers in the United States. In some way or another they must all be prepared for their work. Of these teachers, 189,222 are in the public high schools, and 78,813 in higher institutions (*1*). Since an indeterminate number of teachers in high schools teach, in addition to chemistry, two, three, or even four subjects, the number of such teachers has never been exactly determined. The lack of accurate information on this point and on a number of other pertinent questions indicates the great need of much more intensive study in the whole field of chemical education.

The mere mention of numbers of teachers, however, does not help much in the solution of important problems. An immediate problem is the question of actual conditions of supply of chemistry teachers in relation to the demand. A program of teacher preparation should provide enough teachers to meet the needs of the schools. And it should not provide very many more. Otherwise, salaries drop and the profession loses many of its best prospective recruits.

There is no longer any doubt about a very real condition of oversupply in the liberal arts field in some localities. The New York City press last month carried accounts of some 6000 legally qualified teachers who are on the waiting list for jobs in that one city alone. There are one thousand on the waiting list in Boston. In Philadelphia, the city teachers' college turned away eight hundred applicants for training last year. And so on throughout many portions of the country the story goes. And this in spite of the fact that teaching is comparatively a stable occupation, in the sense that current industrial depression does not affect very much the gigantic industry that is working up raw human material into the future citizenship of this country. There are very few lay-offs of teachers in the profession. The one big factor that causes an oversupply is the continual overproduction in certain fields, of college graduates hungry for jobs, who presume themselves qualified teachers because they have a conventional college education.

The situation seems worse in respect to liberal arts graduates who plan to teach in high schools, although it is not happy in certain other groups. Teachers of special or non-academic subjects, such as music, art, and physical education and health are still in reasonable demand. Teachers of vocational subjects such as agriculture and home economics do not find it

very hard to get jobs. There is an actual undersupply of such teachers in some places.

Teachers of chemistry and the other sciences are not quite so badly off as teachers of such subjects as English and history. Two years ago a questionnaire that included questions inquiring about teacher supply and demand was sent from the Office of Education to state institutions in nearly all the states of the Union. The returns were as follows: In twelve institutions an oversupply of teachers of science was reported; in fourteen, an approximate balance of supply and demand; in eighteen, a condition of undersupply. In liberal arts subjects, such as English, modern languages, and history, thirty institutions reported an oversupply; eight, a balance of supply and demand; and two, a condition of undersupply. One of the workers at the National Education Association in Washington is now undertaking a detailed study of this problem; you should be able to secure his returns within a few months. In the national survey of the education of teachers, now under way, an extensive and detailed study of the whole problem will be made.

One should not be too glib in speaking of an oversupply or an undersupply of teachers, however. In the first place, there may be an oversupply of chemistry teachers in one city or county and an undersupply in another one within the same state. Again, the general condition in a given state may differ from that in another. Most important still is the fact that, regardless of the apparent present condition, you (theoretically) can change it over night by raising certification or employment requirements. If every teacher of chemistry had to have a major in the subject, or if he had to have the master's degree before he could get a certificate to teach, or if he had to belong to the upper fifty per cent of the high-school graduating class before he entered college work, the so-called oversupply would at once disappear. There would be a huge shortage probably. In a very real sense, therefore, the present oversupply of teachers in certain fields is simply an oversupply of undertrained teachers.

The teaching profession is beginning to understand this. Requirements for certification and employment are going up rapidly in many places. The medical profession learned how to handle that matter long ago. You do not enter medicine nowadays unless you take two, three, or four years of premedical or arts and science work and four more years of long, hard, and expensive work in a high-grade medical school, at a cost of $1000 or so per year. The physicians do not complain much of an overcrowded profession.

All of us by constantly working for improved standards in the training of teachers can be of real service to our profession; not only shall we belong to a better profession, but we shall be protected from the crowds of young college graduates who are chiefly interested in getting a job—any job—and are little interested in making teaching a lifetime profession.

Related to this question of supply and demand is the general status of chemical education in the country, in respect to the numbers enrolled in the subject. Is the subject of increasing or decreasing importance? How many teachers should we train in the future?

One measure of college enrolments may be found in the numbers enrolled in chemical engineering. The enrolment in chemical engineering in 1921–22, while the influence of the World War was still on, was 7054; it dropped steadily to 4108 in 1925, and increased again to 5987 in 1928. The post-war deflation is now well over. We may for a while expect a steady but probably not spectacular increase in chemical engineering enrolments. The number of students in non-engineering or pure chemistry in college is not known definitely, but it is much less than the number of students in chemical engineering. Fluctuations in enrolments may be assumed to correspond somewhat as between the two groups.

The total enrolment of pupils in chemistry in the public and private high schools of the United States that reported in 1928 was 230,020, which constitutes seven and three-tenths per cent of a total high-school enrolment of 3,144,645. By no means all the high schools reported, but the *percentage* is not far wrong. Judging from returns in 1922 and in 1928, chemistry is just about holding its own in the high schools. The total enrolment in chemistry, as in other subjects, was greater in 1928, but the percentage of pupils in chemistry in the total high-school enrolment in 1928 shows a slight loss of three-tenths of one per cent over 1922. Physics lost three per cent during the same period. Biology alone among the sciences made a percentage gain amounting to about four per cent; practically all the other physical sciences, and also algebra and geometry, lost in percentages of gain. Incidentally, the greatest gains were in English, about fifteen per cent, and in physical education, ten per cent. Substantial gains were made in commercial work and social science.

It would appear, therefore, that existing agencies and schools for the training of teachers of chemistry are sufficient in number at least to supply present needs. Current conditions of supply of such teachers strengthen this belief. The question of the selection of prospective teachers for training, the qualifications of the training staff, and the general quality of offerings are different matters that will be discussed separately.

Selection of Trainees

In progressive cities and states in many sections of the Union that now have an abundance of teachers there is a decided and unmistakable tendency to require advanced training above the bachelor's degree. California has afforded the best example of this movement for some time; but that section is no longer alone. Faced by an increasing number of applicants with the bachelor's degree, the tendency in a number of cities on the

part of progressive employers is to favor the man or woman with the master's degree, other things being equal. It cannot be said, however, that the mere possession of an advanced degree will meet all the demands of employers. There is a distinct movement nowadays in the colleges to apply selective measures to applicants for training. The teaching profession has never in the past had its full share of the brighter members of the high-school graduating classes. For economic and other reasons, a great deal of poor material has crept into teaching. Educational leaders perceive an opportunity at the present time, while there is an abundance of young high-school and college people applying for training and for jobs, to apply various selective measures. For instance, the requirement may be made that a student must belong to the upper fifty per cent of the high-school graduating class in respect to scholarship before he will be admitted to the college freshman class; he must make a minimum scholarship grade in early college years before he is admitted to student teaching or to the school of education; he must reach a minimum score on an intelligence test; he must possess no serious deficiencies in personality, character, or related traits that may be readily discerned in individual conferences or in his everyday life about the college; he must pass a physical examination; and he must secure authentic and trustworthy recommendations from his high-school principal. These requirements in various combinations are becoming increasingly rigorous in a number of institutions that find it easy to be rigorous so long as they have an oversupply of applicants.

It is admitted that all the selective measures so far employed constitute very coarse sieves. No one measure will keep out all the poor students, and sometimes the rough measures employed keep out good material that could be developed into passable teachers, despite a few handicaps. But the present movement, with all its uncertainty, is an improvement upon the old idea of giving any one training and a job in teaching who could manage to meet the low minimum certification requirements which constitute the coarsest sieve of all.

The movement during recent years in the learned professions other than teaching has been toward the use of essentially selective measures. The doctors who finish two to four years of academic college work, four years of work in a medical college, and a year or two of interneship in a hospital before they are admitted to practice are pretty well selected men. Their profession is the better for it. The same idea of selection to possibly slightly less extent has been applied in the other professions; teaching is just beginning to profit by the idea.

There is one method of selection, positive in nature, that is also coming again to the front. It has always been applied informally by our best college teachers. That method is the discovery, personal encouragement, and advancement of the very few students in a class that have ex-

ceptional natural ability in chemistry. The finding of these rare souls is the chief joy in life of the true teacher. If he can divert legitimately a few such students into a life career in his own field of work, he has made a contribution of substantial value to his profession. This is the one kind of teacher recruiting that our profession needs at all times. If the higher institutions can organize their selective machinery and guidance programs to turn a few geniuses and more scholars into our profession, they will do about as much as they can ever do by barring the misfits, or by encouraging a huge flock of pleasant but brainless young folks to enter teaching, on the assumption that a few of the gifted may be discovered by trial and success on the job.

Too many young college graduates have to wreck the classes of two or three schools before they learn that they cannot teach. We need more instructors originally well selected who can do their job reasonably well without excessive damage to the children and future citizenry of America.

The preparation of teachers has to do not only with the original selection and training of teachers, as determined by the demand for workers to replace heavy annual losses and to fill new positions, but also has to do with the raising of the existing level of training of teachers now on the job, if such level is found to be too low. What are the qualifications of teachers of chemistry? Where must we start, and how far may we go in raising the level, if it must be raised?

We shall consider first the college teachers of chemistry, who must not only themselves be prepared, but who also prepare many teachers. The highest degrees of seven hundred twenty-four teachers of chemistry in forty-nine state-supported colleges and universities distributed over forty-five states are given in Table I, following, for each rank from professor to assistant. The total number of staff members with the bachelor's degree as their highest is one hundred seventy-four or twenty-four per cent of the total. About one college teacher of chemistry in four, therefore, among these institutions has the bachelor's as his highest degree. Thirty-six per cent have the master's degree as their highest, and forty per cent have the doctor's degree. More than half the teachers, therefore, do not have the Ph.D. degree.

The teachers of professorial rank only—full, associate, and assistant professors—make a somewhat better showing, of course. Sixty-two per cent have the doctor's degree. Sixty-seven per cent of the full professors have the doctor's degree. This does not strike one, however, as a particularly high figure. Professors, of course, often bear relatively less of the load of instructing freshmen and other underclassmen than teachers of lower rank. Evidently, therefore, the colleges and the universities can profit immensely by insisting upon much more extensive training and higher scholarship on

the part of the college teachers, especially of the lower ranks, who carry the heavier end of the instructional load.

The degrees earned are usually the bachelor of science, the master of science, and the Ph.D. Roughly, only about one bachelor in four is a bachelor of arts, and one master in four a master of arts. The name of the doctorate is in the great majority of cases the doctor of philosophy; only a very few teachers reported the title doctor of science. A few scattering degrees of varying titles were reported, but the numbers are not significant.

TABLE I

Highest Degrees of 724 Teachers of Chemistry in 48 State-Supported Colleges and Universities

Degree	*All Ranks*	*Percentage*	*Number by Rank*				
			Professor	*Associate Professor*	*Assistant Professor*	*Instructor*	*Assistant*
1	*2*		*3*	*4*	*5*	*6*	*7*
Bachelor's:							
Total	174	24	16	8	15	45	90
B.S.*	125		13	7	9	36	60
B.A.	49		3	1	6	9	30
Master's:							
Total	263	36	36	22	40	92	73
M.S.	196		22	18	25	70	61
M.A.	67		14	4	15	22	12
Doctor's:							
Ph.D.**	287	40	104	52	66	43	22
Total	724	100	156	82	121	180	185

* Includes B.S. in chemistry.

** Includes 2 D.Sc.

Also included are: 1 Ph.B.; 3 C.E.; 1 B.S. in education; 1 M.S. in pharmacy; 1 mechanical engineer.

What is the level of training of high-school teachers? According to the third report of your committee on professional spirit among high-school teachers (*2*), of 217 teachers of chemistry in a selected group of schools of 500 enrolment or more, 216 had the bachelor's degree, 29 the master's, and 9 the Ph.D. More than half these teachers had done work in addition not shown by the mere possession of a degree. Thirteen per cent of these teachers in the larger high schools had the master's degree. It will be recalled that thirty-six per cent of the college teachers had the master's as their highest, although comparisons are not justified on the basis of these data. Four per cent of the high-school teachers had the Ph.D.; and forty per cent of the college teachers. Salaries, however, do not vary in these same proportions.

What are the minimum subject-matter qualification requirements for high-school teachers? In a recent study (*3*) a tabulation of some of the requirements for high-school certificates in all of the states is presented.

The information given is useful to indicate minimum qualifications required of high-school teachers. The following quotation is taken from the study:

> Thirty-three states require graduation from college for secondary-school teaching certificates; one state requires one year of study beyond graduation; and fifteen states do not require graduation from college. However, in some of the states which do not require college graduation there are restrictions as to class of district or school in which non-graduates may be certificated to teach.
>
> The amount of professional work required (*i. e.*, in professional education) varies considerably from state to state. The range is from 0 to 24 semester hours, the median being 15 plus.
>
> Twenty-one of the states require observation or practice teaching or both. Twenty-seven states have no general requirements in this field. The practice-teaching requirement ranges from 2 to 7 semester hours, the median being 5 semester hours. So far as the writer has been able to determine, every state allows credit for this work although it may not be required...
>
> Where there is subject certification, it is no longer possible for the high-school teacher to teach classes in subjects in which he has little or no preparation...Twenty-seven of the states have some type of subject requirement for certification to teach a certain subject.

In high-school teaching, the increase during recent years in state requirements in professional education is of common knowledge. The range in requirements among the several states is, however, considerable.

In a recent study (*2*) of 217 high-school teachers of chemistry, 173, or eighty per cent, were shown to have taken one or more courses in education. Some of the older teachers entered the work before the advent of present-day certification requirements. Nearly all the younger teachers nowadays must take such courses. The median requirements of the higher institutions of the North Central Association that train high-school teachers is now 19.9 semester hours work in professional education. Requirements in professional courses in the colleges, of course, are very strongly influenced by state certification requirements. Both institutional and state requirements tend to become higher from year to year. It is probable that very few public high-school teachers of chemistry will be able to enter upon their chosen work in the future, if they do not offer a minimum of say a full semester's work in the more valuable among the courses in professional education, such as student teaching, educational psychology, principles of high-school education, special methods and materials in teaching chemistry, and similar courses.

In the past there has been considerable difference of opinion between the exponents of teacher-training by means of pure scholarship and mastery of subject-matter in college or in graduate work and the professional education people, especially those who had to train teachers of public school children. In recent years, the demands of public school employers for

professionally trained teachers, that is, those who can handle subject matter to best advantage in the instruction of public school children, have given the education people a decided advantage, since they were originally the chief advocates of such reorganization of subject matter. Lately the more thoughtful among both the professional education people and the subject-matter specialists alike are beginning to get together. The education people say they are willing to cut down on the methods and history of education, and certain other professional content, if the subject-matter people will reorganize, reselect, and readapt their material more nearly to meet the needs of the elementary and high schools. It seems to me this is the best way to settle the argument. After all, both sides are or, should be, working to one end; that is, the most effective development possible of the pupils in the schools. When this aim is clearly seen and acknowledged, there should be no conflict.

In Table II is shown the number of semester hours in professional education taken by 242 college teachers of chemistry. Of the 741 teachers, 499 reported no work in professional education; these are not shown in the table. Thirty-three per cent, therefore, of the entire number have had training ranging from 1 to 70 semester hours in professional education.

TABLE II

Number of Hours Taken in Professional Education by 252 Teachers of Chemistry in State-Supported Colleges and Universities*

Number of Hours	*All Ranks*	*Number of Teachers by Rank*				
		Professor	*Associate Professor*	*Assistant Professor*	*Instructor*	*Assistant*
1	*2*	*3*	*4*	*5*	*6*	*7*
1–4.....	46	6	4	9	13	14
5–9.....	50	8	7	11	10	14
10–14.....	46	5	4	11	19	7
15–19.....	46	1	.	9	16	20
20–24.....	35	4	7	7	6	11
25–29.....	8	3	1	1	2	1
30–34.....	9	2	1	1	3	2
35–39.....	3	3	.	.	.	.
40–44.....	4	.	.	1	3	.
45–49.....	1	.	.	1	.	.
50–54.....	2	.	.	.	1	1
55–59.....	2	.	.	.	2	.
Total number.....	252	32	24	51	75	70
Median.....	13.3	12	11.3	12.5	13.8	15

* Of a total of 741 teachers reporting, 499 or approximately two-thirds have taken no courses in this field.

The median amount of college credit received by those taking work in professional education is as follows: all ranks, 13 semester hours; professors, 12 hours; associate professors, 11 hours; assistant professors, 13

hours; instructors, 14 hours; assistants, 15 hours. You will note an increase in the number of hours taken as you go down the ranks. The teachers are younger in the lower ranks, and received their training during comparatively recent years, during which the subject-matter field of education has been largely developed. As the young men move upward through the ranks, the amounts of training in professional education will probably tend to increase somewhat in the higher levels.

Teaching Experience

Progressive teacher-preparing institutions are more and more interested in securing staff members with public-school experience. Of 753 teachers of chemistry reported on this particular item, 206 or twenty-seven per cent have had teaching experience in the public schools. Returns were received from twelve not included elsewhere. The typical amount of experience of teachers who have had any experience at all is about three years. Ten per cent of those with experience have taught ten years or more in elementary or secondary schools. Staff members with professorial rank have had more experience comparatively than instructors or assistants; as many as thirty-eight per cent of the associate professors reporting have had public-school experience. Detailed data are given in Table III.

TABLE III

Teaching Experience in Elementary and Secondary Schools

Rank	*Number Who Have Experience of—*				*Total Number Having Experience*	*Total Number Teachers Reporting*	*Percentage Having Experience*
	One Year	*Two to Four Years*	*Five to Nine Years*	*Ten or More Years*			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Professor	14	24	8	1	47	158	30
Associate professor	7	14	6	7	34	90	38
Assistant professor	15	14	12	4	45	128	35
Instructor	13	17	6	5	41	193	21
Assistant	14	14	8	3	39	184	21
Total	63	83	40	20	206	753	27

There is no doubt that teaching experience of the right sort in the public schools brings to a teacher much that the college cannot offer. If you will look over typical salary schedules of public schools, you will find that more often than not, the teacher with plenty of experience gets a higher salary than the teacher with much more training, but with no previous experience. The college instructor who trains teachers is handicapped all through his career if he does not somehow inform himself about public-school needs. Some one has said that one's first year in teaching is worth more than any single year he can ever spend in college. Those institutions that can approximate some of the conditions in the public schools in the training of teachers of chemistry have a decided advantage over the insti-

tutions that do not. Here the advantage is seen of having a modern training school and a good training-school staff, and plenty of contacts with public schools, although even in a good training school there is much that cannot be supplied and that must be learned on the actual job itself.

It is not always easy for the smaller colleges to compete nowadays with the wealthier cities in securing teachers, in providing equipment and laboratories, and in other respects. There are plenty of large city high-school teachers who would not accept the salaries offered by some pretty well-known colleges. But there are plenty of teachers with public-school experience that may be secured and that should be secured. They will bring a viewpoint that every teacher-preparing institution should strive to present to its students in training.

Distribution of College Teachers of Chemistry over the Several Ranks

Of 741 teachers reporting, 152 or 21 per cent are professors; 12 per cent, associate professors; 16 per cent, assistant professors; 25 per cent, instructors; and 25 per cent, assistants. A hint is given here as to one means employed by the institutions to cope with increasingly large numbers of students; they employ numerous teachers of low rank and salary, rather than more expensive teachers of higher rank. This particular situation is unfortunate; for while the best men in the institution may be shining lights, they are seen only at a distance by those who need the light most. One full professor to five other teachers of lesser rank is a sadly unbalanced proportion.

Teachers' salaries and teacher qualifications are intimately related. Employers get about what they pay for most of the time. The best people will not enter teaching if they can do considerably better in another occupation. The salaries of 741 college teachers of chemistry are shown in Table IV. The median salary of all ranks excluding the assistants, who are usually part-time workers, is $2904. The median for professors is $4172, associate professors, $3304, assistant professors, $2825, and instructors, $2035. The assistants, on a part-time basis, earn a median salary of $833.

The range is from less than $250 (for assistants) to more than $7750. The lowest salary reported paid to a full-time professor is between $2000 and $2259. These figures do not include salaries of teachers in colored schools, nor, at the other extreme, a very few exceptionally high salaries in the larger privately controlled universities. Salaries were reported for the annual period of employment. This is usually nine months, but sometimes ten, eleven, or twelve. Studies made by the Office of Education show, unexpectedly enough, that teachers of professorial rank, as a group, who are employed in state colleges and universities on a nine-months' basis actually earn slightly more during the year than those employed for

TABLE IV

Salaries of College and University Teachers of Chemistry

		Number of Rank				
Salary	*All Ranks*	*Professor*	*Associate Professor*	*Assistant Professor*	*Instructor*	*Assistant*
1	*2*	*3*	*4*	*5*	*6*	*7*
$249 or less	1	..	..	..	..	1
250–$499	5	..	..	..	..	5
500–749	61	..	..	..	..	61
750–999	80	..	..	..	..	80
1,000–1,249	15	..	..	..	..	15
1,250–1,499	13	..	..	..	10	3
1,500–1,749	39	..	..	..	34	5
1,750–1,999	53	..	1	2	39	11
2,000–2,249	77	1	..	16	57	3
2,250–2,499	44	1	4	11	25	3
2,500–2,749	57	4	12	29	12	..
2,750–2,999	26	1	4	20	1	..
3,000–3,249	60	11	22	25	2	..
3,250–3,499	39	9	14	16	..	..
3,500–3,749	35	19	12	3	1	..
3,750–3,999	19	8	5	5	1	..
4,000–4,249	45	32	12	1	..	..
4,250–4,499	9	6	3	..	..	..
4,500–4,749	17	15	2	..	..	..
4,750–4,999	9	9	..	..	..	..
5,000–5,249	13	12	1	..	..	..
5,250–5,499	..	..	..	..	..	..
5,500–5,749	3	3	..	..	..	..
5,750–5,999	1	1	..	..	..	..
6,000–6,249	8	8	..	..	..	..
6,250–6,499	1	1	..	..	..	..
6,500–6,749	2	2	..	..	..	..
6,750–6,999	0	..	..	..	..	..
7,000–7,249	5	5	..	..	..	..
7,250–7,499	..	..	..	..	..	..
7,500–7,749	3	3	..	..	..	..
7,750 or over	1	1	..	..	..	..
Total	741	152	92	128	182	187
Median	$2400*	4172	3304	2825	2035	833

* This median includes assistants, most of whom are part-time workers. The median for all ranks other than assistants is $2904, which is the more significant figure.

ten, eleven, or twelve months. The difference in salary is not great in any rank. One is tempted to remark facetiously that, if you are a professor, the less work you do in a year the more pay you get.

How do the salaries of teachers of chemistry compare with the salaries of other college and university teachers? A study made by the Office of Education of 10,891 college teachers, in practically the same institutions from which the data for this study were secured, shows that the median

salary of deans is between $5000 and $5200 on an eleven and twelve, and on a nine months' basis, respectively; of professors $4100 and $4300; associate professors, $3200 to $3400; assistant professors $2900 to $2700; instructors, $2200 to $2000. In other words the median salary of teachers of chemistry in all ranks is $200 to $300 more than the median salary of all teachers in the state-supported institutions studied. The salary of professors of chemistry is about $400 more, but these faculty members include a few professors who are also deans. On the whole, if the amount of salary is a measure of the importance of the work, chemistry ranks well among the college subjects. It is entirely possible, of course, that the outside demands of industry help to hold up salaries for chemistry teachers. The institutions could not secure men with ability or earning capacity if they did not pay fair salaries.

No one pretends, however, that salaries paid teachers of chemistry are sufficient. The mere fact that most of these teachers are in the lower ranks indicates that the institutions are still struggling along with entirely too many underpaid men of low academic rank. One of the most essential

TABLE V

Annual Earnings in Outside (Non-Institutional) Work of 158 College and University Teachers of Chemistry*

Amount	*All Ranks*	*Number* *Full Professor*	*All Ranks Other than Full Professor*
1	*2*	*3*	*4*
Less than $250.....	71	16	55
$250–$499.....	28	6	22
500–749.....	31	13	18
750—999.....	7	3	4
1000–1249.....	10	1	9
1250–1499.....	1	1	0
1500–1999.....	4	3	1
2000–2249.....	1	..	1
Over $2250.....	5	3	2
Total.....	158	46	112
Median.....	$321	$519	$261

* Returns were received from 721 teachers, of whom 158, or about 22 per cent, reported supplementary earnings.

points in teacher preparation is the necessity for salaries sufficient to justify promising men to carry through their graduate work to the doctorate, and thus assure themselves of the thorough scholarship that is an essential element among the professorial assets of the superior teacher of teachers.

Do college teachers of chemistry supplement their salaries to any considerable extent by outside work? If so, what do they do? How much do they earn? Some light is thrown on the answers to these questions in

Table V. Of a total of 721 teachers reporting, 158, or about twenty-two per cent, reported that they earned supplementary funds in addition to their regular salary as teachers. Of the 158 teachers who reported additional earnings, 71 earned less than $250 per year. The median earnings of the 158 teachers was $321 per year. A very few reported comparatively large earnings; five teachers reported earnings of $2250 or more per year. One reported $6000, one $7000, and one $15,000. A few did not state their earnings. It is not believed, however, that fear of the income tax collector kept very many from reporting.

The teachers of full professorial rank earned considerably more in addition to their regular salaries than the teachers of any of the other ranks. The median supplementary earnings of forty-six full professors was $519; of all other ranks, $261. The men who receive the lower salaries also earn less on the side. It appears true in colleges that "to him who hath, shall be given."

What do those who earn extra money do? They are engaged in almost any occupation that comes to hand. The most commonly mentioned of the many part-time occupational groups is that of consultants, but the number is not large. The next largest group is composed of writers of books or articles on chemistry. The journals of chemistry and the popular science press are helping keep the wolf from the door of several deserving chemists. After these groups come a variety of occupations, such as beekeeping, attendance at army summer camp, work in church choirs, commercial research workers in chemistry, and officiating at football games.

Less than one-fourth, then, of the teachers earn appreciable amounts of money in addition to their regular salaries. Upon their comparatively modest salaries the bulk of the teachers must depend to support themselves and their families. Too many are forced into work that contributes nothing to their efficiency on their main job. Too many times they are forced into poorly paid work that contributes to their unhappiness and reduces the energy needed for teaching. A great surgeon or lawyer does not have to work at pick-up jobs Saturdays and evenings to enable him to educate his children. May the day soon come when the teacher can say as much.

What is the age of college teachers of chemistry? In Table VI are shown the ages of 741 teachers reporting. The median age of all these college teachers of chemistry is 33 years; of professors, 46 years; associate professors, 41 years; assistant professors, 34 years; instructors, 30 years; and assistants, 25 years. There is, therefore, a range of five years between the median age of assistants and instructors; of four years between instructors and assistant professors; of seven years between assistant professors and associate professors; and of five years between associate professors and full professors. One cannot, however, state on the basis of these data that

TABLE VI

Ages of 741 College and University Teachers of Chemistry

Age	*All Ranks*	*Number by Rank*				
		Professor	*Associate Professor*	*Assistant Professor*	*Instructor*	*Assistant*
1	*2*	*3*	*4*	*5*	*6*	*7*
20–24.....	105	..	..	2	13	90
25–29.....	179	2	3	20	89	65
30–34.....	148	11	14	47	55	21
35–39.....	101	22	27	26	15	11
40–44.....	85	37	27	12	8	1
45–49.....	46	30	6	8	2	..
50–54.....	38	22	10	4	2	..
55–59.....	22	15	4	1	2	..
60–64.....	12	9	2	1	..	..
65–69.....	3	2	..	1	..	..
70 or over.....	2	2	..	..	..	..
Total number.....	741	152	93	122	186	188
Percentage.....	100	21	12	16	25	25
Median.....	32.9	45.7	40.5	34.1	29.5	25.3

a given student assistant, for instance, will spend twenty-one years becoming a full professor since different individuals constitute the two groups. One can use the figure only as a good guess. The difference between the median ages of instructors and full professors is sixteen years. One is permitted the guess only that this period represents the time of progress through the ranks. The young college instructor in any case, however, who looks forward to a college teaching career in chemistry may well expect a long period of waiting before he becomes a full professor. The difference in the median salaries of instructors and professors is $2137. Again, one cannot say that the average yearly increment in the salary of a given teacher, or even of a group, is $146, for the data cannot be used in this way; but the figure is an interesting guess that may give one more idea of what the career of a college teacher is like. One must remember, too, the selective influences that weed out many teachers who never reach the rank of full professor. Only the fittest, perhaps, survive.

In any case, it is perfectly clear that teaching in college does not, for superior men, offer anything like the financial opportunities for superior men in law, medicine, or a number of other occupations. Fortunate indeed is the teacher whose temperament is such that he loves his work. No other type of man should be encouraged to undertake the long period of training necessary to attain any considerable degree of success in teaching.

The Curriculum

Only brief mention can be made here of the numerous curricular problems with which the teacher trainer is confronted. The first that may be mentioned concerns the unnecessary overlapping and duplication of content

between high school and college. While not all duplication is to be condemned, excessive duplication between high-school and college chemistry is serious. Some standard college texts do not contain as much as a fifth more than some high-school texts. Much work of early college grade is in reality of secondary grade. In particular, the courses in inorganic chemistry are characterized by repetition of content.

A study recently came to my attention that had the rather interesting conclusion that freshmen who study college chemistry do just about as well in the college subject if they have never had any high-school chemistry as they do when they have had the course in high school. I have heard instructors say the same thing regarding their students. Here we have a first-rate problem that is worthy of a great deal of study.

Duplication of content is not confined to chemistry, but constitutes a very real problem of modern secondary and higher education. There are movements to integrate more closely high-school and college work, whereby duplication may be reduced and time saved. For instance, it is proposed in a few places to organize the whole school program on a 6-4-4 basis; that is, six years of elementary school education, four years of high-school education, and four years of college education, followed by university work beginning with what is now the junior year in college. The whole program above the sixth grade, according to this scheme, is stepped down somewhat; the junior high school plus the one year of the senior high school constitutes the new high school, and the junior college and upper two grades of the senior high school constitutes the new college. Whether or not this particular scheme is adopted, the movement is indicative of changes that characterize modern education, and that we must consider when tempted to rely too much on tradition for our sole guidance.

Another curricular problem is that of deciding upon the proper subject-matter combinations that a trainee should take in college. The whole matter of supply and demand is also involved here.

Teachers of chemistry, especially in the small high schools, are frequently called upon to teach other subjects, such as physics, general science, biology, and mathematics. Not infrequently teachers are called upon to instruct in two, three, or even four or more different subjects. Employers are often negligent in placing teachers in the positions they are best qualified to fill. This condition is being remedied in progressive states by certification by subjects as in West Virginia and other states. Teacher trainers must coöperate in preparing trainees for teaching the combination of subjects demanded in the schools. It is not an ideal situation, but it demands a practical solution. Teachers solely of chemistry should major in this field.

With a growing condition of oversupply of teachers, proper advisement of students will assist in helping them to secure employment most advan-

tageously, and at the same time afford the maximum possible service to the schools. Local state or regional needs, as ascertained through studies by the institution or by the state department of education, will help advisors and students in determining proper study combinations in a given institution.

Another curricular problem arises in the extraordinary variety of demands upon the high-school teacher. He is more than a teacher of a given subject; he is a teacher of young people and a member of a school community of wide interests. He will have a broad range of semi-administrative duties, and community contacts, and even some clerical work to handle. Some of his best opportunities for influencing the lives of his pupils will come outside his classroom.

Charters and Waples, in their Commonwealth Teacher-Training Study, list 1001 activities commonly undertaken by teachers. Learning is specific. In one way or another, some kind of training must be given in as many of these activities as possible. Not all can be handled in the classroom; but it would be of profit for every teacher to study this list, and answer the question: "Just what am I doing to prepare my students for each of these activities?" He would approach his task with new humility and considerable enlightenment.

A great deal nowadays is being said about vitalizing our courses in the arts and science subjects in high and elementary schools. In some places the term "professionalized subject-matter" is used to designate teaching materials selected and organized in accordance with the findings of educational psychology, with the experience of skilled teachers, and with the judgments of curriculum builders who have studied carefully the actual needs of pupils in everyday life. The customary logical arrangement of subject matter in some of the sciences, the topics selected, and the methods of teaching have been severely attacked at times. Education cannot remain static in an age changing so rapidly as this. The teacher must study the causes for the changes coming into our schools. He can do this best by himself attending graduate schools. If he does not in some such way keep up to date he will find himself in the position of a hopeless conservative, in opposition to almost any new movement in education; he has reached the end of his education, and his career in teaching is largely over.

Inevitably, as the young teachers get their experience, the older teachers, no matter how good they once were, are going to be supplanted by a new staff trained in accordance with the needs or demands of a newer generation. The only safeguard of the older teacher is to keep reasonably well up in his own professional training.

Another problem that must receive attention as chemistry teaching advances in the future is new changes of emphasis in the subject matter taught. Advanced training in organic, quantitative, qualitative, physical, industrial,

and other phases of chemistry is growing at the expense of other phases emphasized in earlier days. Educators are growing more and more to feel that the influence of mere tradition should be lessened in the selection, organization, and presentation of subject matter, and curricular construction put on a purely functional basis. The study necessary to make real progress in the field of curricular development is simply tremendous. The expenditure of millions of dollars in research on the matter of curricular research would not be too much; for the curriculum and the way you teach it, in order to arrive at the true objectives of training young people, are the only really important problems. Problems of administration, plant, and equipment, and so on, all seem insignificant when you get into the problem of what you teach in relation to the life needs of pupils. To analyze life itself and then set up means to modify our living, is a pretty big job.

The matter of special methods, in the narrow sense of instruction in devices, is no longer stressed so much in teacher education. However, there is a promising field of research in the whole matter of how to teach. I have listed some conclusions from recent studies, usually of limited scope. Probably no one of the conclusions is the final word, yet each of them gives one something to experiment with in his everyday teaching.

1. The accomplishment of project classes, measured by standardized tests, is slightly better than that of non-project classes.

2. Distinct gains over the usual plan of teaching are realized by an intensive plan of directed study.

3. Aims of teaching chemistry vary widely among schools. More uniformity is desirable.

4. There is too much parrot-like repetition of textbook material in the teaching of chemistry. Broader knowledge of teachers would vitalize much of this teaching.

5. High-school chemistry cannot be taught successfully purely as a memory subject.

6. One of the purposes of high-school chemistry teaching is to enable students to find their abilities along this line. The able should be encouraged to carry on; the poor, to obtain the maximum benefits to the extent the subject is pursued.

7. The general principles involved in the specific cases studied should be emphasized under all circumstances.

8. An important emphasis in the teaching of chemistry is to show the services of chemistry to the home, to health, to medicine, to agriculture, to industry, etc.

9. Too many students do not learn the definitions of common terms.

10. There is a weakness in the knowledge of students of important industrial processes.

11. Few students possess the ability either to write names of chemical substances from their formulas or the formulas from their common names.

12. It is futile to expect students to be able to write more than a few entire equations for given chemical processes or reactions.

A discussion of the status of teacher training in the United States is largely an account of one phase of an endless process of educational evolution. Changes are slow; tradition is strong. For example, even in this

day of separated state teachers' colleges—the number has increased from 46 to 136 in the past eight years—the traditional arts and science institutions still remain teacher-training institutions to an extent that even most of their faculties do not comprehend fully. Two hundred nine of these colleges recently reported to the N. E. A. Committee on Articulation that of 37,000 graduates with the bachelor's degree, forty-two and six-tenths per cent went into teaching. Recent studies have shown that sixty to eighty per cent of the Ph.D. graduates of our leading universities enter teaching. The proportion may be a little less among chemists, since some enter industry, but it is not much less. The training of teachers is thus one of the most important, if not the most important of the functions of the vast bulk of the colleges, just as it has been for a long time. The kind of training staff members in the arts and science colleges have, therefore, still determines to a substantial degree the kind of high-school instruction we shall have in the future. Teacher-training remains a distinctive activity, therefore, that the college teacher must perform whether he is interested in it or not.

Current changes of varying significance, however, often give rise to some thought concerning the many complex factors entering into the general program of teacher training. A few items may be mentioned. The birth rate of this country is decreasing; consequently, the enrolments in the elementary schools have reached practically a standstill. However, the American people are thoroughly sold to the idea of education. The outlay for the schools constantly increases. Enrolments in elementary schools do not. Does this mean that as the wealth of the country increases, we shall expect a new era of development of our schools, with a new and finer emphasis on quality, as a result of having increased means to buy quality? The number of men in teaching is now slowly increasing, contrary to the tendency of a few years ago. What economic factors are at work? Enrolments in teacher-training courses are not increasing so rapidly as a few years ago. This may result from a number of unanalyzed factors, such as the lengthened training period now required, the working of the law of supply and demand, and several other factors. The expense of training teachers has increased over a long period of years. It varies greatly among the large and small institutions. What efforts will be made in the future to control the location of teacher-training institutions, so that more economical programs of training will be possible? A half dozen of the larger universities have during the past ten years seriously entered the field of preparation of college teachers, with emphasis on the more characteristic elements of teacher preparation as advocated by educationists. What are the possibilities of this field? These and many other questions indicate that the present status of teacher preparation is in a period of change that may give to us a quite different picture of the field within

another generation. In this connection should be mentioned one of the chief purposes emphasized nowadays in the education of teachers. This is the upbuilding of a professional group of trained people that in prestige and ability will compare favorably with members of the learned professions.

The development of chemical education in the more characteristic elements of a genuine profession has been largely confined to the present century. The American Institute of Chemical Engineers, for instance, was not organized until 1908, hence, as a profession, this particular group of chemical engineers is one of the youngest groups of the new profession of engineering. Today from nine to eleven per cent of the engineering profession are chemical engineers. Chemistry as a field is of course much broader than the field of chemical engineering or applied or industrial chemistry, but is being built up in the same way.

The teaching of chemistry as well as of other subjects in the proper sense is also largely a development of this century. The growth of scientific and semi-scientific methods of research in educational psychology, statistics, sociology, tests and measurements, curricular analysis, school and classroom administration, school finance, and so on, has resulted in the accumulation of a body of knowledge that has given education just claim to recognition as a new and genuine profession. Our group grows in dignity and prestige as it develops more and more not only a specific field of knowledge but also the other attributes of a profession.

In the past, the large turnover of teachers, who usually serve only about five years in the high schools, led to the charge that we had a teaching procession, rather than a teaching profession. This condition is still serious, but hope lies ahead. Teaching is less and less a stop-gap between college and law, business or matrimony. To a decreasing extent, we call our occupation a profession with our tongues in our cheeks. Learning to teach is becoming somewhat less a matter of learning endless detail and more a matter of finer development of high-school youngsters for genuine living. As teachers we are more and more in earnest about building up a worthy career, with the services and rewards worthy of a genuine profession.

The development of scientific research, and the establishment of norms of practice, are among the greatest developments in education in all time. Research has now become a matter of national interest. The last Congress appropriated $200,000 for a survey of teacher training on a national scale. The purpose, according to the wording of the Act, is "to make a study of the qualifications of teachers in the public schools, the supply of available teachers, the facilities available and needed for teacher training, including courses of study and methods of teaching." This survey began July 1, 1930. When this study and other studies of the future are completed, the line of advance on the irregular frontier of knowledge will again be ad-

vanced, and I trust that all of us will be nearer the day when the basis for educational procedure on the part of intelligent teachers will be not the unscientific dictates of tradition, but an adequate body of "organized, systematized, knowledge" about a profession second to none in importance to the human race.

Literature Cited

(1) *Bureau of Education Bulletin*, **1929**, No. 14, and *Bulletin*, **1929**, No. 38.
(2) J. CHEM. EDUC., **7**, 1366–70 (June, 1930).
(3) KINDER, "Requirements for Secondary School Teaching Certificates in the Case of Persons without Teaching Experience," *Sch. Rev.*, **38**, 110–4 (Feb., 1930).

THE QUALIFICATIONS OF CHEMISTRY TEACHERS IN SECONDARY SCHOOLS*

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The growing importance of chemistry in industry and culture necessitates the best instruction possible in the schools. The secondary-school teacher of chemistry needs a certain amount of specialized knowledge and training. A certain amount of mathematics and other sciences is desirable. Some knowledge of teaching methods is also desirable. Certain qualities that are looked for in students should find their highest expression in the teacher.

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I shall use considerably less than the forty minutes allotted to me to speak on the qualifications of chemistry teachers in secondary schools, not because this aspect of the question of teacher qualifications is less important than those aspects which the following speakers are to discuss, but because the whole situation can be expressed in one short sentence.

That person is best qualified to teach high-school chemistry who has; (1) a love for the subject itself, (2) a love for pupils, and (3) a love for the job of transferring the subject to the pupil.

That, to my mind, expresses, in a nutshell, my contribution to this symposium, but of course you will immediately be reading into these three phases of the question certain very important details. It is those details which we might profitably consider for a few moments.

First, love of the subject itself implies a thorough knowledge of so much of the subject as is necessary to do one's work effectively.

Those of us who are old enough to remember how little chemistry we needed to teach our pupils thirty to thirty-five years ago to fit them to pass

* Contribution to the symposium on "The Qualifications of Chemistry Teachers" held by the Division of Chemical Education at the 80th meeting of the American Chemical Society, at Cincinnati, Ohio, Sept. 10, 1930.

the entrance examinations for college will realize easily to what extent the entrance requirements have been increased during this period. It is evident therefore that the subject-content qualification of the chemistry teacher of today is of considerable importance.

That the knowledge of subject-content is not likely to be reduced any in the future is evident, (1) from the possibly greater interest of modern youth in things scientific, (2) from the opportunities afforded by the student science clubs of today, (3) from the increasing reluctance on the part of the student to accept statements simply because "the teacher says so," and (4) from the recent increase in printed scientific matter of a popular nature for the lay reader.

It would seem therefore that the chemistry teacher should have had, as a minimum, college courses in general inorganic chemistry, organic chemistry, qualitative analysis, quantitative analysis, and physical chemistry, the first because of the basic principles and general information involved, the organic because of the important rôle organic substances play in the life of today, the two analytical courses because of the practice in laboratory technic they give, and the last because of the increasing work on the border line between chemistry and physics.

The foregoing is the speaker's personal opinion but it corresponds closely, though not exactly, with the findings of the Division's Committee on Preparation of High-School Chemistry Teachers (*1*) of which a later speaker in this symposium, Dr. A. J. Currier, is chairman; it agrees similarly with the Preliminary Report of the Committee on Education of the American Institute of Chemists (*2*) and with a number of individual and committee pronouncements.

I have in mind the teacher who is fortunate enough to teach chemistry only. In that case he would do well to have as a background those other undergraduate courses in chemistry which are ordinarily given in college, in order to give him added chemical background. Mathematics should have been pursued through analytical geometry. Of course, English should have been pursued each year up to graduation from college with special emphasis on ability to express one's self in clear and correct manner. Ability to read scientific French and German is still a desirable, and occasionally a necessary, accomplishment. A course or two on methods of teaching and on education are desirable, usually helpful, and often required by law for teaching in a public school system. If there is room and time for any "remaining subjects" the prospective teacher should certainly be given opportunity to choose such as appeal to him (or her).

All the foregoing applies to the person for whom chemistry is to be the only subject on his (or her) teaching schedule. How about the high-school teacher who must teach other subjects in addition, for unfortunately there are still "some such" in the United States?

E. W. Phelan (*3*) in his article on "The Status of Chemistry and the Chemistry Teacher in the Ohio High Schools" points out that in from two-thirds to three-quarters of the county and city high schools investigated, chemistry teachers had to teach one, two, or three "other subjects"; and in some cases as many as five or six other subjects. Now, let us not for a moment assume that Ohio is the only state in which such conditions exist, for the evidence is to the contrary.

What is the solution? *Theoretically*, the prospective teacher should specialize in college just the same in proportion on these "other subjects" as it was just indicated he should specialize on chemistry, but *practically*—well, that is another question. He simply does not "qualify," and we hear and read of what A. M. VandeVoort (*4*) in her article on the normal school and teachers' college situation calls "the inadequacy of the preparation of teachers."

When G. Zeismer (*5*) says that "forty per cent of the (science) teachers (in Wisconsin) have not majored in science and, obviously, are not prepared, or very meagerly prepared at best, to teach the science subjects," we hesitate to lay the blame on the teachers.

Dr. J. E. Mills (*6*) has pointed out that "in some states a student who has satisfactorily specialized in chemistry at his state university, following exactly the course recommended by the institution, and who has received the degree of bachelor of science in chemistry, is not allowed to teach chemistry in any accredited high school of his state." The trouble seems to be that the number of semester hours of educational work required for a teacher's certificate precludes sufficient time devoted to the subject specialized in. Obviously, if a properly "qualified" teacher of chemistry is desired he should be given opportunity to qualify himself properly.

Our second qualification—a love for pupils—seems perhaps less definite than the love for the subject itself but it is none the less important.

Some one has said that *students* should be: interested, reliable, neat, accurate, careful, conscientious, thorough, serious, punctual, studious, honest, ambitious, polite, diligent, willing to work, inquisitive, enthusiastic, investigative, and able to follow directions.

Why should we not add to this that the chemistry *teacher* should also have these same qualifications?

It is a truism that children are imitators. So are we older children for that matter. How can the teacher, who has the pupil's interest at heart, better inculcate the desirable qualities just mentioned than by being a living example of them himself (or herself)?

Such "living example" instruction is well illustrated by: (1) carefulness and skill in the manipulation of apparatus, (2) accuracy in taking measurements, (3) system, order, and neatness in the arrangement of apparatus, and many similar procedures which readily occur to one.

For the teacher to manifest the above qualities, certain qualities of a less chemical nature are helpful, namely, character above reproach, pleasing personality, good health, respect for law and religion, etc., and these should not be neglected.

The third qualification—love for the job of transferring the subject to the pupil—is so closely associated with love for the pupils that many of the things just mentioned apply here also.

From the title one thinks first of courses in education as the best source of help. J. O. Frank (*7*) says:

> Since chemistry teachers have to teach in high school, it is obvious that they must thoroughly understand teaching at the high-school level and especially the teaching of high-school science. We must provide for not only an understanding of secondary education, but also technic in teaching.

On the other hand, Brownell and Wade (*8*) say:

> It is very likely that theory and methods courses in education have been so divorced from whatever subject matter is to be taught as to become mere abstractions, and in many cases but a shibboleth of the vocabulary of education, lacking in vital relationship and significance.

How shall it be determined whether a teacher has the desired qualifications? Let us cull our answer from a recent article by F. C. Coulson (*9*) of the Roosevelt High School, Chicago. Among other things, it says:

> The chief aims of elementary chemistry should be: (1) to give the pupils an idea of the importance and significance of chemistry in our national life, (2) to give information of definite service to home and daily life, (3) to develop specific interests, habits, and abilities which should be contributed by all sciences, (4) to secure an element of continuity in science by knitting together previous science work through recall and through the presentation of principles—new ones and elaboration on old ones, and (5) to help the student discover whether he has an aptitude for further work in pure or applied science and to induce such pupils to continue science studies in the university or technical school.

If the teacher is achieving these results, why ask if he (or she) has the requisite "qualifications"? College admission committees and college chemistry teachers may measure the high-school teacher's qualifications by the results of set examinations or by the student's ability to continue the study of chemistry in college. State and community boards of education may have their own criteria of the qualifications necessary to teach chemistry successfully, but a consideration of these may be a little beside the question at present. In the last analysis, is not the teacher himself (or herself) the best judge? The teacher who has the three loves mentioned at the beginning of these remarks, and whose vision and effort is constantly forward and upward certainly knows instinctively whether the qualifications are present or absent.

That this subject of qualifications is timely and important today is evidenced by a number of facts: (1) the presence of this symposium on our program, (2) the activity of the numerous committees of our Division bearing on the problems of the teacher, (3) the three-year survey of public-school teacher training recently initiated by the Office of Education of the Department of Interior to make a study of the qualifications of teachers in the public schools, the supply of available teachers, the facilities available and needed for teacher training, including courses of study and methods of teaching, (4) the work of the Committee on Professional Training appointed by the Central Association of Science and Mathematics Teachers, especially their recommendation that "courses offered in the teaching of high-school subjects or in practice teaching be taught or supervised by instructors who have been trained in subject matter as well as in methods of teaching" (*10*), to say nothing (5) of the many individual investigations bearing on this subject as evidenced by numerous articles in the printed publications which reach the teacher's desk.

Is there any solution to the questions arising out of the consideration of the qualifications of high-school chemistry teachers? We should be untrue to the trust imposed on us by our association with this Division of Chemical Education if we were other than optimistic for the future solution of these questions.

As some of the steps in the right direction we might mention: (1) a greater and constant effort on the part of the teacher to perfect himself (or herself) in the knowledge of chemistry and other directly associated tools of the job, (2) sharing our successes and problems with others through joining an association of chemistry teachers, (3) getting school principals and boards of education to recognize the difference between instruction in chemistry and that in other subjects to the extent of providing the chemistry teacher with the proper conditions under which to work, and (4) then finally measuring up to the enlarged opportunities.

Finally, let me close as I began: That person is best qualified to teach high-school chemistry who has: (1) a love for the subject itself, (2) a love for pupils, and (3) a love for the job of transferring the subject to the pupil.

Literature Cited

(*1*) A. J. CURRIER, *Chairman*, "How Are Teachers Being Trained in College for Teaching High-School Chemistry?" J. CHEM. EDUC., **5**, 744–5 (June, 1928).

(*2*) CROSSLEY, "Preliminary Report of the Committee on Education of the American Institute of Chemists," *Chemist*, **7**, 11 (March, 1930).

(*3*) PHELAN, "The Status of Chemistry and the Chemistry Teacher in the Ohio High Schools," J. CHEM. EDUC., **6**, 2196–202 (Dec., 1929).

(*4*) VANDEVOORT, "Trends and Tendencies in the Teaching of Chemistry in Normal Schools and Teachers' Colleges," *ibid.*, **7**, 387 (Feb., 1930).

(5) ZEISMAN, "Academic and Professional Training of Science Teachers in Wisconsin," *Sch. Sci. Math.*, **29**, 942 (Dec., 1929).
(6) MILLS, "Educational Requirements for Teachers of Chemistry in Secondary Schools," J. CHEM. EDUC., **7**, 2259 (Oct., 1930).
(7) FRANK, "Teaching First-Year Chemistry," 4th ed., J. O. Frank, Oshkosh, Wisconsin, **1927**, p. 108.
(8) BROWNELL and WADE, "The Teaching of Science and the Science Teacher," The Century Company, New York City, **1925**, p. 141.
(9) COULSON, "Educational Aims in Teaching Elementary Chemistry," J. CHEM. EDUC., **6**, 1122–5 (June, 1929).
(10) KURTZ, "Report of Committee on Professional Training," *Sch. Sci. Math.*, **30**, 336 (March, 1930).

THE QUALIFICATIONS OF CHEMISTRY TEACHERS IN COLLEGES AND UNIVERSITIES*

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A plan for the preparation of college teachers, where the students are selected for their personal qualifications as well as for their scholastic record is outlined. The plan has four main objectives: (1) mastery of content of the subject to be taught; (2) experience in research within the field of the subject taught; (3) adequate training in methods of teaching as applied to chemistry; (4) practice teaching under supervisors. It is hoped that this plan will result in an improvement in chemical education through the coöperation of the chemical industries and the chemistry department of The Johns Hopkins University.

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The subject assigned to me is one involving questions identical with many which confront us in the work in which we are engaged at The Johns Hopkins University. Hence I shall discuss these problems largely from the standpoint of our own attack upon them in so far as it has already proceeded.

The time at my disposal might be emp'oyed in outlining for you a verbal portrait of the ideal university instructor in chemistry—but to what profit? Others have already done the same thing and, no doubt, better than I could do it. Most of us will recognize this *rara avis* if we ever encounter him but few of us have any idea where his natural habitat may be or how he may be bred in captivity.

The question which may profitably engage our attention at the present time is not: "What constitutes an ideal college chemistry teacher and where can we trap some?" It is: "Can we produce better college teachers

* Contribution to the symposium on "The Qualifications of Chemistry Teachers" held by the Division of Chemical Education at the 80th meeting of the American Chemical Society, at Cincinnati, Ohio, Sept. 10, 1930.

than we are now producing and, if so, how?" Practical suggestions are needed—not day-dreams.

Any one who is at all skeptical about the interest taken by presidents of colleges and universities in the qualifications of their faculties should read the March, 1929, issue of the *Bulletin of the Association of American Colleges*. It is clear that the colleges and universities are considering the teaching problem from every angle. Fifteen colleges reported that they have specific committees established for the improvement of college instruction. Twenty-one reported that they are planning the establishment of such committees. In other colleges similar work is being accomplished through deans of colleges or heads of departments.

Besides the Association of American Colleges there are many other national, regional, and local organizations which have been making a special study of college teaching during the past two years. Also some universities are making it a special issue. I understand that the University of Minnesota has been making a very special study of college teaching, and that Stanford, Harvard, New York, and Columbia have definitely organized plans for the preparation of college teachers. The University of Chicago is about to embark upon some definite program for the special preparation of college teachers, if we are to judge from the following statement by President Hutchins (*1*):

> The graduate schools of arts, literature, and science are, of course, in large part professional schools. They are producing teachers. A minority of their students become research workers. Yet the training for the doctorate in this country is almost uniformly training in the acquisition of a research technic, terminating in the preparation of a so-called original contribution to knowledge. Whether the rigors of this process exhaust the student's creative powers, or whether the teaching schedules in most colleges give those powers no scope, or whether most teachers are without them is uncertain. What is certain is that most doctors of philosophy become teachers and not productive scholars. Their productivity ends with the dissertation. Under these circumstances the University of Chicago again has a dual obligation; to devise the best methods of preparing men for research and creative scholarship and to devise the best methods of preparing men for teaching.
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> Since the present work of graduate students is arranged in the hope that they will become investigators, little modification in it is necessary to train those who plan to become investigators. In the course of time it will doubtless become less rigid and more comprehensive, involving more independence, and fewer courses. But the main problem is a curriculum for the future teacher. No lowering of requirements should be permitted. No one should be allowed to be a candidate for the Ph.D. degree who would not now be enrolled. In fact the selection of students in the graduate schools on some better basis than graduation from college seems to me one of the next matters the University must discuss. But assuming that this is settled, and assuming that a student who plans to be a teacher has been given a sufficient chance at research to determine his interest in it, his training should fit him as well as may be for his profession. This means, of course, that he must know his field and its relation to the whole body of knowledge. It means, too, that he must be in touch with the most recent and most

successful movements in undergraduate education, of which he now officially learns little or nothing.

How should he learn about these movements? Not in my opinion by doing practice teaching upon the helpless undergraduate. Rather he should learn about them through seeing experiments carried on in undergraduate work by the members of the department in which he is studying, with the advice of the Department of Education which will shortly secure funds to study collegiate education. Upon the problems of undergraduate teaching his creative work should be done. Such a system places a new responsibility upon the departments, that of developing ideas in college education. But it is a responsibility which I am sure they will accept in view of the history and position of the University of Chicago. Such a system means, too, that different degrees will doubtless have to be given to research workers, the Ph.D. degree remaining what it chiefly is today, a degree for college teachers. But however opinions may differ on details, I am convinced, as are the Deans of the Graduate Schools, the Deans of the Colleges, and the Chairman of the Department of Education, that some program recognizing the dual objectives of graduate study—the education of research men—must be tried at the University of Chicago.

We are not inclined, at Hopkins, to agree with President Hutchins that differentiation in training should be made between prospective teachers and prospective research men. Too often any attempt at such differentiation demands powers of prophecy beyond those which we or the student himself are qualified to exercise. Furthermore, we believe it desirable that the teacher should be as thoroughly trained in the fundamentals of his subject and in methods of creative work as the non-teacher. However, the broad general outlines of the situation which confronts us are well set forth in the foregoing quotation.

With these conditions before us it seems very fitting that we should assemble here today as chemistry teachers and take stock, as it were. What are our college and university chemistry departments doing to meet this situation? Do we as chemistry teachers need to heed this movement, or are our departments so well manned by good teachers that the presidents of our respective institutions will pass us by. Personally, I believe that our college and university chemistry teaching can be improved. And if this is the case no stone should be left unturned to bring about this improvement, for every thinking chemist realizes that the destiny of our American chemistry is in the hands of our college and university chemistry teachers. How is this? The type of students attracted into our chemistry departments and the superiority of their education depends on the type of men doing the teaching and the type of men attracted to our profession and their training determines the future of American chemistry.

During the past few years millions have been appropriated for research and large research institutions have been built and equipped. Every one should realize, however, that these appropriated millions may be squandered without productive results unless we can furnish a perpetuity

of properly qualified men and women to direct the activities of these institutions and lay out plans for the expenditure of the appropriated money. Good teachers at the college and university level constitute our only assurance that such a supply of properly qualified workers will be available.

It was the realization of this fact that caused Francis P. Garvan to establish the Chair of Chemical Education in the chemistry department of The Johns Hopkins University, and to encourage us to do everything possible to produce some outstanding men in chemistry, hoping that some of them at least would enter the teaching profession. A brief outline of our plan at The Johns Hopkins University will give you the best concept of the qualifications which we believe college and university chemistry teachers should possess.

Our program has resulted in a so-called National Fellowship Plan, supported through the coöperation and generosity of various chemical industrial firms and of a few enlightened and public-spirited individuals.* In the study we have undertaken, equal emphasis is laid upon the selection of men to be trained and the training of men selected. In order to limit the project and, at the same time, place it upon a truly national basis, the plan adopted makes ultimate provision for one student from each of the forty-eight states. In order that men of unusual promise but limited means shall not be debarred by lack of funds, a four-year fellowship of one thousand dollars annually is offered in each state. Selection is made from the sophomore, junior, or senior classes of the colleges and universities of the respective states. The time of selection is indicated by the desirability of obtaining students as soon as possible after they have had reasonable opportunity to determine the field in which they desire to specialize. It is, furthermore, in harmony with the present general plan of The Johns Hopkins University, which affords students an opportunity to begin their studies leading to the doctor's degree after the completion of the sophomore year in college provided they have had the requisite preparation.

The selection is accomplished through state committees which evaluate the student's complete previous scholastic record and personal qualities as rated by his instructors on the chart on page 92.

To illustrate the table let us select the heading "Creative Ability." The five columns mean that there are at least five types of students. First, there is the type of man who can really discern a problem and solve it.

* AMERICAN CAN CO. (3), J. T. BAKER CHEMICAL CO., BILL RASKOB FOUNDATION, BROWN CO. (2), CARBIDE AND CARBON CHEMICALS CORP., CENTRAL SCIENTIFIC CO., THE CHEMICAL FOUNDATION, INC. (2), COCA COLA CO., H. A. B. DUNNING, DU PONT CO., FIRESTONE TIRE AND RUBBER CO., FLEISCHMANN YEAST CO., FRANCIS P. GARVAN (3), GENERAL MOTORS CORP. RESEARCH LABORATORIES, JOHN M. HANCOCK, HORMEL FOUNDATION, KEWAUNEE MANUFACTURING CO., ELI LILLY CO., W. A. PATRICK, G. A. PFEIFFER, WILLIAM SHALLCROSS SPEED, U. S. INDUSTRIAL ALCOHOL CO., WILLIAM R. WARNER & CO., JOHN WILEY & SONS, INC.

RATING CHART

(Name of Applicant)

(Address)

(Name of fellowship for which applied)

CHARACTERISTICS (alphabetically arranged)	Please place the percentages in those squares which nearest characterize the candidate. 90-100	80-90	70-80	60-70	Below 60%	Do not use.	
Book Ability: Capacity to learn from books.	Exceptional	Very good	Moderate	Slow	Dull		
Character:	Very high ideals	High ideals	Moral	Careless	Immoral		
College Standing: Marks on subjects which you have taught candidate.	Excellent	Good	Fair	Poor	Failure		
CHEMISTRY:							
MATHEMATICS:							
PHYSICS:							
ENGLISH:							
Conduct: Cooperative attitude toward others: consideration for others.	Exceptional	Very gentlemanly	Well behaved	Unsatisfactory	Annoying		
Creative Ability: Initiative, imagination, originality, resourcefulness, ability to see and solve problems.	Very surely original	Can solve problem after it is suggested	Can solve problem if occasionally helped	Has to be helped considerably	Helped all the way		
Enthusiasm: Energy, interest put into work: enterprise.	Exceptional	Enthusiastic	Interested	Lacks interest	Uninterested		
Executive Ability: Efficient in organization of his work, apportionment of his time, etc.	Very efficient	Good	Fair	Poor	Very poor		
Experimental Skill: Technic as shown in laboratory work.	Very skilful	Good	Fair	Poor	Very poor		
Faculty of Observation: Power to observe and record results accurately.	Exceptionally accurate	Accurate	Average	Inaccurate	Unobserving		
Health: * As far as you know. (Explain any defects under Health Remarks below.)	Very vigorous	Vigorous	Healthy	Often sick	Sickly		
Intellectual Honesty: Does he observe what actually takes place or is he influenced by preconceived ideas?	Absolutely dependable	Practically dependable	Shade a result	Seems to have little conscience	Almost hopelessly unreliable		
Judgment and Common Sense:	Unusually sound and keen	Good	Fair	Poor	Very poor		
Perseverance: Application, persistency.	Exceptional	Good worker	Steady	Dilatory	Lazy		
Personality: Conveys an impression of sincerity, ability, agreeability, etc. Good personal appearance.	Excellent	Good	Fair	Poor	Very poor		

REMARKS

* HEALTH

GENERAL

Use other side if necessary

Use other side if necessary

Reported by: Name

Address

NOTE.—Use other side to give your personal judgment of student's natural ability and possibilities of his future attainments in chemist...

There is another type of man who, if you give him the problem, will work it out fairly well, although he would never have seen it for himself. There is thirdly the man who, given a problem and a little help, will work it through. Fourthly, there is the type of man who has to be helped considerably in order to solve the problem, and lastly the man who has to have the problem worked for him. (Of course, we are trying to select only those men who fall in the first class.) Similar distinctions may be seen under each of the other characteristics on the chart.

One of these rating sheets is filled out by each student's chemistry, physics, mathematics, and English instructors, respectively. These four teachers are likely to come the nearest to the student during his first two years of work. When the charts are returned by the professors of the various applicants, they are sent, with the college records of the students, to the state committees. The committee in each state narrows down the list to three or four of the best men and makes the final selection by interviewing and examining them personally.

Thus far fellowships have been established in twenty-nine states of the Union and one in England. We had counted on operating the plan on a national basis only, but it looks very much as if it were going to be international. Since we were late in getting started the first year we have as yet had only nine men under the new plan but we have twelve more for this year and we expect to select twelve men each succeeding year, *i. e.*, when the plan is in full operation there will be approximately twelve of these men entering the university each year and approximately twelve receiving their Ph.D. degrees and leaving. I am glad to say that thus far there have been no disappointments in the selections. Every student is very promising at the present time.

After these men have been selected by the state committees, it is necessary that we do everything possible for them. The selection is important, but the training is also important, and we do not wish to shirk our responsibility in any way. In the training of these selected men, fundamental courses in mathematics, physics, and English, as well as in the four major branches of chemistry (inorganic, organic, physical, and analytical), are emphasized. There is no attempt to specialize in the various applications of chemistry. The elective system of study for the student is under an advisory committee of the department.

These selected men are required to select and solve problems without any direction from the staff. This is in addition to the usual Ph.D. dissertation, where such dissertation is usually worked out in conjunction with some professor. This provision tests whether or not these selected students are properly rated in column one of the table on page 92.

We can't force people to teach, nor are we attempting to do so, but we are going to see that these men are prepared to teach, should they wish

to do so. How are we doing this? We are giving the selected students exactly the same amount of chemistry for a Ph.D. as has always been given at The Johns Hopkins University, and, in fact, more, as already noted, in the way of original research work. In addition, they are given four courses, two of which we are now anticipating will be given outside of the chemistry department as broad fundamental courses; one in psychology or educational psychology and the second in philosophy or history of education. Then the chemistry department gives these students two broad courses in chemical education, one applying these fundamental educational principles to the teaching of chemistry where such application covers theory, observation, and practice, and a second course which takes up the development of the great theories of chemistry, together with a study of the great personalities of our science, especially emphasizing those personalities whose characteristics have made them stand out in the world as great teachers or great investigators. It also enables the students to survey the chemical field, to see how its laws have been built up and to learn something of the men who have been instrumental in building them up.

Since we are not sure whether these students will teach or go into the industry, we require them to spend at least two summers in the industries, with the idea of letting them find out for themselves whether or not they like industrial work, and also with the idea in mind that the industrial experience will be of great value to those who take up teaching.

The following extract from a letter received from a student near the close of his first summer's work shows the wisdom of the summer work policy:

> My summer job is now nearly over and I am writing you as I believe you will be glad to hear of some of my experiences.
>
> First of all I will say that I have never had a summer go so quickly. I suppose that is because I have had very interesting work to occupy all of my time. I always had quite a heavy program too on my week-ends at home.
>
> I have had the most splendid companions to work with in the laboratory and since the lab. is relatively small I have gotten to know them all very well. I really believe that I have learned a great deal of chemistry, mostly of course about catalytical problems. What is even more important I have learned a great deal of laboratory technic that I believe I could acquire in no other way. We have made some real discoveries during the summer's work, and I regard it as quite a privilege to have had my small part in them. It really gives one quite a thrill to unearth brand-new, unrecorded phenomena.
>
> The experience has been valuable in helping me to decide that I really want to do university teaching and research work after I get my degrees. . . .

In addition to this fundamental curriculum, we have introduced many features which we think worthwhile. For example, Dr. Alfred R. L. Dohme has made it possible, through a visiting lectureship, for us to give

the students an opportunity to come in contact each year with about ten of the leading scientists from this country and abroad. A prominent scientist is invited to visit the chemistry department each month of the academic year. He arrives in the morning, visits the research laboratories and consults with the students upon their research problems. The students ask him questions and he asks them questions. At four o'clock he lectures to the students on the subject for which he is noted. In the evening the visiting scientist takes dinner with the students, when they meet him socially around the table. Thus, they make contact with this man at three different points. They have his opinion on their research problems, they have heard his lecture, and they have met him socially. Hence, when they receive their Ph.D. degree, which requires approximately four years they go away knowing approximately forty outstanding scientists outside of their own department. This is already proving itself very interesting and valuable.

We are following such lines and introducing such ideas as we believe are most likely to develop the abilities of the selected students and make of them the best men possible. We don't claim they are going to be geniuses; we claim only one thing—that we are going to do our utmost to select the best men possible, and then we are going to bend every effort toward producing the best scientists we can from those whom we have selected.

We trust that this careful selection and extensive training will so prepare men that should they choose teaching as a profession they will be qualified to teach in any college or university.

Literature Cited

(1) HUTCHINS, "The Spirit of the University of Chicago," *J. Higher Educ.*, **1**, 9–10 (Jan., 1930).

THE TRAINING OF TEACHERS IN SERVICE*

B. S. HOPKINS, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

The training of teachers of chemistry in college or university should implant a broad understanding of the subject matter as well as an adequate training in modern methods of presentation. The most important part of the training of the successful teacher is obtained as a result of his own efforts in service. He must study his pupils, his local interests, and keep in touch with advancing thought. He must read wisely, sift his material carefully, and take advantage

* Contribution to the symposium on "The Qualifications of Chemistry Teachers" held by the Division of Chemical Education at the 80th meeting of the American Chemical Society, at Cincinnati, Ohio, Sept. 10, 1930.

of every opportunity for self-development. The university system of employing graduate student-teachers offers an opportunity for the thorough and systematic training of teachers in service. Teachers so trained should know what to teach and how to teach it.

. . . . . .

We are chemists, proud of our science, its rapid development, its versatility in time of war, its usefulness as an agent of peaceful industry, its importance as a leading factor in our exacting modern civilization and its possibilities for future growth and development. The history of the world has witnessed few more rapid periods of growth or more important developments from an educational point of view than the strides which have been taken by science since that epochal event on August 1, 1774, when Joseph Priestley first prepared oxygen and unknowingly laid the foundation for the science of modern chemistry. At no period during its one hundred fifty-six years of growth and service has the development been more rapid or produced more startling innovations than has the decade which followed the close of the World War. We as Amercian chemists may perhaps be pardoned for our pride in the accomplishments and growth of the American Chemical Society, its record of usefulness and its imposing list of active and progressive members. All students of human affairs agree that chemistry has arrived and that it promises undreamed-of comforts, conveniences, and safety devices for future generations.

In the midst of our pride for the accomplishments of our predecessors and our fellow chemists, let us not forget that the admiration and wholesome respect which chemistry has earned bring to the shoulders of the passing generation a responsibility which we are unable to dodge. It is our most solemn duty to develop the next generation of chemists so that they may take up our unfinished tasks with a clear mind, an observant eye and keen judgment, in order that chemistry may continue to serve in an increasingly complex system of living. It is not enough for chemistry to maintain its present position of respect as a factor in education; it must continue to grow as it has done in previous generations.

The task of training the chemists of the future rests primarily with the teachers of chemistry of the present generation. From the papers and discussions which have already been heard in this symposium it is evident that the qualifications of a successful teacher are high and that the gravest responsibility rests upon him who undertakes to train the teachers who in turn are destined to train the coming generation of chemists. To be a teacher of teachers is the task supreme. Who is willing to assume such a responsibility? How may its duties be efficiently discharged?

The training of teachers of chemistry is easily summarized under two headings: (1) that obtained in college or university under the direction of a person of experience; (2) that which the teacher gains for himself under

his own initiative in the hard school of experience. Both of these phases of teacher training are vitally important for the science of chemistry. The training in college should be centered around two points: (1) implanting a knowledge of the subject matter of chemistry which should always extend beyond the boundaries of the field in which the teacher is expected to instruct; and (2) developing the ability to teach so that each topic may be presented in a clear and logical manner. In our present educational system colleges and universities almost invariably present the subject matter in a thoroughly competent and efficient manner, while schools of education do an excellent service in training teachers in the most acceptable modern methods of teaching. How fortunate we would be if these two viewpoints could be combined because both are essential for the development of successful teachers. Relatively few colleges are giving adequate training in the best methods of teaching chemistry and this training is very sorely needed. Normal schools are too prone to overlook the necessity for a thorough training in the fundamentals of chemistry as a prime prerequisite for the teaching of the subject. All should recognize the fact that the teacher of chemistry is continuously confronted with two extremely vital questions: "What shall I teach? How shall I teach it?"

It is indeed a fortunate individual whose training has included an adequate study of the subject matter of chemistry as well as a skilful drill in the methods of presentation. Such a combination is certainly a good beginning, but it by no means marks the end of the period of training. By far the most important portion of the teacher's training comes from his own experience in the classroom and the laboratory. If we are to become successful teachers in the largest sense we must study our problems, improve our methods and show consistent growth from year to year. If we do not progress we will be left behind in the rapid development which characterizes our scientifically minded age. We must advance or we will lose ground and become hopelessly out-distanced. There can be no stationary engines in chemistry; either we must move with the traffic or be left behind by the procession.

One of the first maxims in efficient teaching in any field is that an interested student is almost invariably an industrious student. Lack of interest causes indifference, slothfulness, and trouble. Nowhere does this statement apply with greater force than in the teaching of chemistry. One of our first duties is to study the needs and interests of the community in which we live as well as the home environment of our students and their probable future lines of activity. The city dweller is interested in the applications of chemistry to the manufacturing processes with which he is familiar, in the usefulness of chemistry in refrigeration and the preservation of foods, in the fighting of fires, in the production of power in his automobile, and in the numberless phenomena which enter his daily life. The

student from an agricultural region is interested in problems concerning the maintenance of soil fertility, the most efficient feeding program for the dairy herd, the care and handling of dairy products, the control of insect pests and many other problems in which chemistry is a direct aid in modern agriculture. The student of home economics is interested in the problems of the household and the numerous applications of chemistry to foods, fabrics, sanitation, and community improvement. The pre-medical student is vitally interested in the materials used as medicines, drugs, antiseptics, in the struggle for the prevention of disease and in the problem of adequate water supply and efficient sewage disposal. It is not necessary to go into these topics exhaustively for time does not permit, but if interest is kindled, a well-directed course in outside reading may supplement the regular class exercises and this will do much to stimulate the habit of serious reading—a habit which is one of the greatest assets of education. To present these applications without consuming too much time requires both skill and forethought, but the increased interest and intensified motive on the part of the pupil fully justifies the effort. But this is not the greatest benefit which follows the plan of adapting our teaching to the viewpoint of our students. In preparing to present these applications as an integral part of the course in chemistry the teacher is broadening his own horizon and increasing his own interest in the affairs of his day and generation. This is the best preventive for keeping out of the rut which leads to educational oblivion.

But we must remember that successful teaching involves subject matter as well as method. Consequently the chemistry teacher who is ambitious to increase his own usefulness must adopt some plan for keeping in touch with the advancements which come in such bewildering abundance. The habit of systematic and orderly reading of scientific journals is one of the most vital points in each teacher's plan of training himself for his profession. The question of what to read is frequently a puzzling one, because chemical literature has become so voluminous that it is quite overwhelming. In general, the reading should be done along lines of personal and community interest, and the journals which are read regularly should be selected along these lines. We as chemistry teachers are especially fortunate in having a journal which is especially designed for our particular needs. Its able editor selects his material in such a way that each number answers both the what and the how of chemistry teaching. It covers the important advances, gives concise and readable articles on topics of current chemical interest, and gives in abstract a concise summary of the leading articles in other journals which are of interest to the teacher of science. I know of no one journal which can compare with the JOURNAL OF CHEMICAL EDUCATION in all around usefulness for the teacher of chemistry. For greater detail the other publications of the American Chemical Society are unex-

celled in the fields which they cover, while there are many other able magazines which may be made available at small cost.

Progressive teachers also receive inspiration and help from intimate association with others who are doing the same sort of work. Membership in the American Chemical Society brings one into step with an army of 17,000 chemists, many of whom are teachers. In addition to receiving the publications of the society each member receives the inspiration which comes from united effort in a common cause and the friendship of those who face similar problems. The Division of Chemical Education is organized for the specific purpose of aiding teachers of chemistry in every possible manner. Under its patronage in the various states there are organized associations of chemistry teachers which bring the stimulating effect of such organizations within the reach of all. Much good results from membership in such a group, attendance upon its meetings, and participation in its programs. By entering into such activities each teacher not only crystallizes his own thinking and profits by the experience of others, but he is at the same time aiding others in a mutual effort at self-improvement. The united effect of active groups of progressive teachers will accomplish much in improving the status of the chemistry teacher and the educational value of chemical instruction.

It is very evident from the trend of thought up to this point that the author has had in mind particularly those teachers of chemistry who work alone or in small groups which are more or less isolated from the larger centers of chemical thought. Let us now turn our attention for a few minutes to another phase of the problem of the training of teachers in service.

The larger universities almost invariably depend upon graduate student-teachers for most of the routine instruction in large elementary courses like chemistry. The charge is frequently made that this system has grown up because it permits an institution to furnish teachers for large numbers of its undergraduates at a very low cost. The inference is drawn that little attention is paid to the quality of the instruction but that the teaching assistants are encouraged to rush through their pedagogical duties in the easiest and quickest manner possible in order that they may turn their undivided attention to their own research work which they regard as the only worthwhile undertaking on their programs. It must be admitted that the system of employing graduate students as teachers of elementary courses can give rise to serious abuses and that such abuses may produce vicious results in our educational system. When rightly administered, however, the system has real merit and deserves to be recognized as an important factor in the training of our youth. It is not the present purpose to discuss the merits and demerits of this system as a whole for that has already been done in a most thorough manner by a committee of eminent

educators appointed by the American Association of University Professors. The report of this committee is given in the *Bulletin* of the Association for February-March, 1926. This report is based on 364 replies to a questionnaire which had been mailed to a carefully selected group representing a wide range of departmental interest, geographical distribution, and educational viewpoint. The committee recognizes that the system may be permitted to develop such undesirable features as the employment of the plan in institutions which do not have a well-developed graduate school; inter-university competition which results in offering various inducements, such as increased stipend, shortening of the time requirement or general looseness of scholastic standards; consideration of the stipend as a subsidy for graduate work or the building up of a graduate department, which induces incompetent, or poorly prepared college graduates to undertake work for which they are wholly unfitted; overloading schedules in an effort to acquire an advanced degree in a minimum of time, thereby encouraging superficial work in both teaching and graduate courses. But the committee fails to find evidence that these faults exist to any appreciable extent and reports no evidence of their presence in departments in which there exists well-developed graduate work.

On the other hand, the report of this committee calls attention to a number of points in which the graduate student-teacher system is distinctly superior to the plan of employing mature teachers only. (1) Most of the graduate students are largely dependent upon their own financial resources and of necessity must have some income in order to continue in graduate work. By engaging in part-time teaching many a capable individual is able to give himself a more thorough training for his life work than would otherwise be possible. (2) "It is practically impossible to secure experienced teachers to carry year after year the type of teaching conducted by graduate student-teachers. And the opinion seems to be widespread that the experienced teacher carrying such work soon loses more in enthusiasm than is compensated for by his experience. . . .The standards of teaching have not been lowered by the employment of graduate student-teachers. What they lack in experience is compensated for by the enthusiasm which they bring to their work." (3) The scholarship of a graduate student is materially improved by teaching in elementary courses because it affords a very thorough review of the fundamental facts of the science. (4) It permits a graduate school to test the teaching ability of its graduates. The experience gained and the opportunity to test each individual's adaptability to teach are of prime importance and become an undeniable duty before a candidate can be recommended for a teaching position. Teaching brings to the surface many traits of character which otherwise would never be brought to light and no person should be allowed to teach who does not possess the proper "personality" for teaching. There is no surer way of

"knowing the man" than is gained through observation of his success as a teacher. (5) If a graduate student-teacher is given a reasonable schedule and adequate direction and encouragement he is serving an apprenticeship under the guidance of experienced teachers who will be able to help him overcome some of the difficulties and avoid some of the pitfalls which are the common experience of the beginning teacher.

It is this last phase of the graduate student-teacher system which especially concerns us at the present time since it affords an excellent opportunity for the training of teachers in service. Our educators have found that there is a distinct advantage in building into our system of instruction the plan of "learning by doing." Every teacher must begin somewhere and it seems to be inevitable that a beginner must make mistakes which experience teaches him to avoid. If the individual can learn his trade under the kindly advice and friendly supervision of a successful teacher, and working in conjunction with teachers of experience, he will become a capable teacher much more quickly and many times he will become a better teacher than would be possible if he made his debut under circumstances where he is left entirely to his own resources.

The objection may be raised that many of our graduate students are not planning to enter the teaching profession but are definitely looking forward to positions in the industries. Of what possible use to such a person is teaching experience? My answer is this: our graduate schools are doing their best to prepare young people for leadership wherever they may be employed. So it is safe to say that sooner or later each successful graduate will be called upon to tell others how certain work should be done or to instruct their fellow workers in the details of some intricate process. This is teaching in its fullest sense and the methods of the teacher are essential for the successful discharge of duties of this kind. It is a most fortunate requirement, which is occasionally met, that all candidates for the doctor's degree must include some teaching experience in their training. For no matter how commercial their job may appear to be it will some time develop circumstances under which the ability to teach is indispensable.

The training of teachers in service may be accomplished in many ways, but in all of these the success of the plan depends almost wholly upon the initiative of the individual. Colleges may give training which is invaluable to the beginning teacher, but they cannot insure growth in after years. The teacher who is satisfied with his preparation and position may neglect all means of self-improvement if he will. He will soon become antiquated and he will either seek other employment because teaching has no future or he will become resigned to his fate and grumble constantly because the other fellows get all the "breaks." The ambitious teacher, the individual with a vision, who sees beyond the monthly pay envelope and beholds something of the possibilities of service to his day and generation, will eagerly

utilize the means of improvement which present themselves and seek to make each day and each year better than his predecessors. Such a teacher will unconsciously become one of the beacon lights of civilization marking the pathway of human progress toward the highest ideals of which the human race is capable.

REPORT OF THE COMMITTEE ON PREPARATION OF HIGH-SCHOOL CHEMISTRY TEACHERS*, **

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Studies made by the committee during the past three years are discussed and the following conclusions are stated:

1. More extensive training in chemistry and in other sciences is urgently needed in many cases.

2. These needs should be met either by decreasing the requirements in educational courses, by increasing the number of credits required for graduation (above the 120 minimum), or by graduate study.

3. Orientation or special methods courses are now provided in over seventy colleges and universities. Many teachers in service regard these courses as a valuable part of their training.

4. Accrediting agencies and state departments are, in many cases, not specific as to the amount of training in science required in certification of such teachers.

. . . . . .

The Committee on Preparation of High-School Chemistry Teachers has endeavored to make a thorough study of the problem of the training of teachers of chemistry (and other sciences) in the secondary schools, in view of the fact that the present status in this field is so unsatisfactory. Accordingly, three formal reports have been submitted to the Senate of The Division of Chemical Education of The American Chemical Society (*1*), (*2*), (*3*).

Since the publication of these reports, Dr. J. E. Mills (formerly chairman of the Division of Chemistry and Chemical Technology of the National Research Council and a member of this committee) has presented further

* Contribution to the symposium on "The Qualifications of Chemistry Teachers" held by the Division of Chemical Education at the 80th meeting of the American Chemical Society, at Cincinnati, Ohio, Sept. 10, 1930. This report is submitted to the accrediting agencies for consideration.

** This article constitutes the fourth formal report of the committee on Preparation of High-School Chemistry Teachers. See references (*1*), (*2*), (*3*) at end of article.

† Chairman of the committee. The other members of this committee who have helped prepare this report are: HENRIETTA HAYDEN, LOUIS W. MATTERN, T. A. ROGERS, and J. E. MILLS.

evidence of the deplorable standards set for the training of chemistry teachers in secondary schools throughout the country. He says (*4*):

> It was repeatedly pointed out that the high-school teachers of chemistry were often inadequately prepared to teach that subject. It was common knowledge that in general, the training of high-school teachers in chemistry did not equal the training expected of junior chemists in the government service, or the training expected of those entering a commercial laboratory.
>
> Much more surprising was the fact that at the present time in some states a student who has satisfactorily specialized in chemistry at his state university, following exactly the course recommended by the institution, and who has received the degree of bachelor of science in chemistry, is not allowed to teach chemistry in any accredited high school in his state. In fact, very few of the teachers of chemistry in the accredited universities and colleges of the country could qualify to teach chemistry in the accredited high schools of many states. On the other hand, teachers possessing only the most elementary knowledge of chemistry are allowed to teach chemistry in the high schools of many states provided the teacher has taken certain specified educational work.
>
> . . . The result of the present requirements is that most of the teachers of chemistry in the high schools have far less knowledge of chemistry than is expected of junior chemists in the government service or the new recruits in industrial laboratories. In other words, the high schools require of their teachers of chemistry less knowledge of the subject than is generally supposed to be necessary for its successful use in any other way. In fact the knowledge of chemistry required is so limited that the teacher often has not obtained a sufficient foundation for graduate work and usually cannot later make good his deficiency by post-graduate work that can at the same time be used as college credit for an advanced degree.

The problem of post-graduate work for chemistry teachers has been investigated by this committee in coöperation with the Committee on Professional Spirit among High-School Chemistry Teachers (*5*).

It was shown that of 217 teachers of chemistry only twenty-nine hold the master's degree and nine the doctor's degree. More training in organic, analytical, physical, and inorganic chemistry (named in the order of emphasis) was urged by these same teachers in their questionnaire interviews. The majority of these teachers regarded certain standard educational subjects as essential but secondary to the fundamental training in chemistry. The Committee on Professional Spirit among High-School Chemistry Teachers reported that with the present requirements in educational subjects in effect, the only solution to the problem is an additional year leading to the master's degree. This requirement, however, can hardly be expected to be met to any large extent until the status of high-school teaching is materially improved.

There appears to be a wide difference of opinion among educational administrators, teachers, and specialists in science as to the actual value of the educational subjects required by the accrediting agencies and state departments of education. Some knowledge of psychology as related to the learning process, educational sociology, and school administration are quite generally considered as essential equipment of the teacher regard-

less of his special field but the value of such courses has been overemphasized, in many cases resulting in a sacrifice on the side of sound training in science or other academic fields of major interest (*4*).

It is now quite generally conceded that some sort of an orientation or "methods" course is desirable as a part of the training of the chemistry teacher (*5*). The average senior in college with a major in chemistry or the inexperienced teacher has little or no knowledge concerning the planning and management of a laboratory, the purchase of supplies, the planning of demonstrations, lessons, and class schedules, the preparation and grading of examinations. He is also unfamiliar with recent investigations on what topics should constitute a high-school course and the most effective methods of teaching it.

This need is met with varying success by the so-called "special methods" courses which have been introduced in over seventy colleges and universities. The writer has given such a course for the past six years. That such a course is justifiable is attested by the many favorable comments voluntarily offered by former students now teaching chemistry in secondary schools. Such courses, in the opinion of the committee, should in all cases be given by a member of a chemistry staff who has had some experience in teaching in secondary schools, who has a broad and unbiased view of the whole educational problem and who is, of course, well trained in chemistry. Such requirements are not met in many cases due to academic prejudice, specialized interests, etc.

Practice teaching by the future teacher under actual school conditions and careful supervision is not easy to provide but it is now provided by a number of the larger institutions as well as the teachers' colleges.

The question of more extensive training in chemistry brings up another pressing problem; the fact that the vast majority of the secondary schools need teachers who are well prepared to teach physics, biology, general science, and perhaps mathematics in addition to chemistry. Frank points out that only about seven per cent of the chemistry teachers in the country teach chemistry alone (*6*). It appears that a large number of teachers who are responsible for two or more sciences besides chemistry have but little training in more than one science (*7*).

To the university professor, this requirement may seem unreasonable and difficult to meet. It is a natural and practical situation, however, which must be met. In brief, while the universities tend to train specialists (in chemistry) the schools need "generalists," *i. e.*, teachers who also have additional training in sciences other than chemistry. In Germany more emphasis is placed on thorough training in related sciences than in America (*3*). The smaller colleges in this country tend to meet this requirement perhaps better than the universities where the professional attitude in chemistry is more in evidence. The reorganization of curricula

for future chemistry teachers, so as to provide more requirements in other sciences, is one of the most pressing problems.

In the study of "Curriculum Requirements in Various States" (*2*), the committee found that only fourteen of the forty-four states that responded to the questionnaire (1929) stipulate definite subject matter in addition to educational subjects in their requirements for certification of teachers, *e. g.*, eighteen hours in chemistry and ten hours in other sciences. "*The remainder of the states (thirty) or nearly seventy per cent grant a blanket certificate which entitles the holder to teach any subject in the high-schools of the state. This situation, in the opinion of the Committee, is an extremely unsatisfactory one and calls for modification.*"

How May the Training of Chemistry Teachers Be Improved?

The facts of the situation now appear to be well in hand. The committee has worked diligently for three years to this end. The status of teacher training both in this country and abroad has been clearly shown in the committee's reports. The views of teachers in service and of other interested persons have been expressed in the questionnaires summarized in the reports and in this symposium. Mills makes specific recommendations as follows (*4*).

> It is suggested for the consideration of those concerned that a high-school teacher's certificate should be based on the following requirement:
>
> Graduation from an accredited college or university with not less than 40 semester hours training in the subject or subjects taught.
>
> Professional training in educational work not to exceed 12 hours may be accepted as partial fulfilment for the required semester hours.

Gordon has summarized the whole problem in a recent editorial (*8*), a portion of which follows:

> Many states legally fix the required number of hours to be spent in the study of education so high that little time is left out of the usual one hundred twenty hours minimum necessary for graduation to be applied to the subject or subjects which the student expects later to teach. Obviously it is beside the point to learn "how to teach" when one has learned nothing to teach. What is the remedy? It is folly to attempt to tinker with the state laws, but the accrediting agencies, fortunately, have the final say. Let them demand that teachers be adequately prepared in the subjects which they undertake to teach.
>
> This seems difficult if we are to regard the one hundred twenty hour minimum as a fixed limit. But why should we? Any but a poor, or at least a mediocre, student can carry eighteen semester hours without difficulty and make good grades. No student who has to weasel through college on the absolute minimum of credits should aspire to instruct others, nor should he be encouraged in such ridiculous aspirations. Let the accrediting agencies demand more than an absolute minimum of scholastic achievement in high-school teachers and the schools will have to come to terms.

The committee respectfully submits the results of its work, with the endorsement of the Division of Chemical Education of the American

Chemical Society, to the state departments of education and to the accrediting agencies for their serious consideration, with the hope that what has been presented may be of some value in improving the status of science instruction in our schools.

Literature Cited

(1) "How Are Teachers Being Trained in College for Teaching High-School Chemistry?" J. CHEM. EDUC., **5**, 743–7 (June, 1928).

(2) "Curriculum Requirements in the Various States," *ibid.*, **6**, 1156–7 (June, 1929).

(3) "The Training of Teachers of Chemistry in Secondary Schools in Some Foreign Countries," *ibid.*, **7**, 1363–6 (June, 1930).

(4) "Educational Requirements for Teachers of Chemistry in Secondary Schools," *ibid.*, **7**, 2259 (Oct., 1930).

(5) "Professional Spirit among High-School Teachers of Chemistry, III," *ibid.*, **7**, 1366–70 (June, 1930).

(6) FRANK, "Teaching First-Year Chemistry," fourth edition, J. O. Frank, Oshkosh, Wis., **1927**, p. 7.

(7) HUSTON, *Educ. Admin. Superv.*, **9**, 423–38 (1923).

(8) EDIT., "Incompetence Guaranteed by Law," J. CHEM. EDUC., **7**, 2221 (Oct., 1930).

Propane as Liquid Gas Enters Isolated Kitchens. Liquefied propane, a new industrial gas preparation, is now available to country fuel-gas consumers who have no access to domestic gas lines. It is delivered under moderately high pressure, up to ninety pounds, in portable steel tanks, ready to connect to the kitchen stove.

Propane is not new to the laboratory. This is, however, probably the first time that a single chemical substance has been extracted from petroleum in liquid form for sale to the everyday retail fuel consumer. All other allied fuels, such as gasoline, benzine, kerosene, and the like are uncertain mixtures of a host of substances.

For some years there has been a small trade in a very volatile mixed fuel extracted from "wet" natural gas. Such a product contains not only propane, which boils in its pure state at 49 degrees below zero Fahrenheit, but other substances of quite different boiling point, such as butane, boiling at 33 degrees Fahrenheit, and pentane, 98 degrees Fahrenheit.

When a polyglot fuel of this sort is allowed to escape from its domestic pressure tank into the kitchen stove, the propane part unfortunately comes out more rapidly than the other substances. Later, as the material is used up, the supply becomes mostly butane and pentane. These gases give too rich a mixture in the stove burner. The flame tends to become sooty.

Under the new system, the single substance, largely freed from impurities, is stored in the tank. The gaseous product comes uniformly throughout the full life of the tank charge.

The manufacture of the gas is suggestive of the industrial preparation of pure alcohol from a fermented solution, such as mash or molasses, by fractional distillation. In the case of propane the boiling points of the materials are so low that the whole operation has to be conducted under high pressure. It is then possible to condense the desired gas without recourse to expensive refrigeration.—*Science Service*

AN INTRODUCTION TO THE PRACTICE OF ORGANIC CHEMISTRY*

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The proper scope and content of an introductory course in organic chemistry for universities, the course being offered to students of other subjects for professional use (doctors, engineers, etc.), as well as to students of chemistry proper, are discussed. Therefrom follows an indication of the changes already effected, or to be effected, in the methods and scope of the teaching of the course in Columbia University, New York City. Directions for the preparation of caffeine from tea are included.

. . . . . .

In a scheme of education for general cultural purposes there is probably no place for a course in Practical Organic Chemistry. It is an item in the curriculum that has little merit as an intellectual discipline, has a handicraft value too slight to mention in the life of the average citizen, and could probably be easily replaced by other more exact experimentation courses for illustration of scientific method and deduction, if that virtue were under consideration. It falls into place in the curriculum as a necessary item in the professional training of certain groups of students and is justified in the curriculum presumably on the ground of necessity alone. In the usual introductory class, however, the degree of importance of the work varies greatly among the students and it is a common observation that the students other than those intending to make a profession of chemistry itself lack interest in the usual procedures of the course, are often careless of details that are of real importance to a mastery of the technic, and attain a level of efficiency which is often far below their average. Even for the students of chemistry proper there exists a body of opinion as to the unsuitability of the usual procedures. The usual procedure may be summarized in the statement that the student completes a set of experiments which illustrate the more common general reactions of the various classes of compounds, therein meeting examples of the commoner methods of operation employed by the organic chemist. The usual text, from which the students work by exact repetition, may or may not be amplified with reference to the literature of the specific preparation, or questions designed to test the student's analysis of the logic of the preparations, or his knowledge of the properties of related compounds. In an examination of the question of the best method of dealing with the various groups of students found in the usual introductory class, we must admit these known uninterested attitudes of many of the students (often a majority of the class), and even admit the fact of criticism from many teachers of the usual procedures dealing with chemists alone. Thus the following occurs in the preface of one of the older organic manuals of excellent repute:

* Contribution No. 643 from the Dept. of Chemistry, Columbia University, N. Y. C.

> The old and drastic method by which chemistry was made to fit into a syllabus consisted in cutting out the core of the subject, or in other words, in removing all the processes which demanded time, skill, and some intelligence and in reducing the examination to a set of exercises in a kind of *legerdemain*... It is to be hoped that the kind of examination...will in time be superseded or accompanied by a scheme encouraging candidates to show, in addition to their notebooks, evidence of skill or originality, as, for example, in submitting specimens of new or rare preparations, or in presenting an account of some small investigation.

One can well believe that the usual procedures represent an attainable best in the institution where resources are small, but it seems more than probable that they are not the ideal, are perhaps capable of improvement in any circumstances.

This paper starts with the statement that the course is justified on the ground of necessity: it must be added that this necessity must be the spring of the student's interest, and it is postulated that the differences in achievement between the student of chemistry proper and his coworker who is not a professional chemist arise from a realization on the student's part of the valuelessness of much of what he does in the laboratory. Whether or not the procedure is proper for the chemist, it is less suitable for the doctor, engineer, or what not. If possible, then, this fact must be faced and action taken on its merits. Wherever possible, the interest of the student must be enlisted, an enlistment that is voluntary on the grounds of self-interest, his work being preparatory to his profession. Thus the organic practice that the doctor must learn is one he might need. If he needs none at all, then the course must be dropped from his syllabus as a waste of time: there is no other justification for it. Furthermore, it is by no means proved that the customary set of preparations is the proper procedure even for the student of chemistry: here again we may be losing the support that can be obtained by enlisting the student's interest. The tests of efficiency may be wrong, the requirements unsound. The question set to us in this university is roughly this: given a mixed set of students, many of whom will not proceed beyond one year, all of them needing at least a little knowledge of the practice: given that the future need of the student is the spring of his own interest in the general case: given that the usual procedure is probably not ideal in any case; what changes are necessary or desirable in the teaching of the course in an institution lacking nothing in resources, allowing full freedom of action to the teacher?

An attempt, still under way, has been made in this university, under the supervision and instigation of Professor J. M. Nelson, to answer this and related questions from the given ground. It is the purpose of this paper to discuss the matter as it relates to the first-year students only, the further progress of the student to be the subject perhaps of a later discussion.

In order to plan work for the students some answer must be given to the question of the general purpose of the different experiments. It is realized that a certain minimum of practice is necessary for all of them, including the operations of distillation, crystallization, etc., usually met with in the texts. This minimum must be given to all of them, either as direct exercise or in the course of a preparation. Tradition and good sense unite to state that the latter method is preferable—preferable, indeed, because of the chance it gives to have the student's interest aroused. The more variation of procedure the better the training, but an elaborate schematic variation is perhaps not possible or desirable in the course of one year (a point that seems to be tacitly admitted in the formulation of the usual text, the examples in which are chosen to illustrate, as first content, not general technic but examples of general reaction).

Now the matter of general reactions is, in the opinion of the author, not one that properly belongs in the laboratory at all. It is postulated by some that the laboratory work helps in the memorization of the theory, but such a small result alone would not justify the enormous amount of time spent, even if the postulate were true. It is also often assumed that the examples of general reactions are typical of the work of the chemist in his profession. Actually, they are not examples of the method of work of the average doctor or engineer, in as far as he uses the subject of organic chemistry, and they resemble, but only poorly, the method of the research chemist alone. Consider any such example at hazard (a reduction of ketone, for example, given, as a rule, with sodium and alcohol). Is it to be assumed that the research chemist takes a new ketone, of any class, and repeats the given preparation with a view to its reduction? Is it not true that the real practice (and always the student must learn a needed practice) is more likely to be an examination of the methods formerly most successful with that class of ketones, or nearest representatives, a formulation of an experiment on a small scale which is either a copy or suitable variation, an examination of the factors which make the new different from the old, and the resultant use of the proper technic which is nearly always simple technic of distillation, crystallization, or the like? Later comes an attempt at improvement of yield, nearly always a matter of logical variation of single factors in accord with observed results. *Therefore it is taken that the matter of general reactions can be neglected entirely in the laboratory.* If this is the case, and if we can arrange a fair amount of experience in the variations of the fundamental operations in the course of the student's work, it matters nothing what experiments he performs. Luckily the operations of the organic chemist are not many, and it will be admitted that some practice in all of them can be gained by a very small number of well-devised preparations. Furthermore, it would be almost impossible to let a student work for one year in the laboratory at

any experiments at all without finding that, at the end of the year, he has repeated the fundamental operations many times over.

We are allowed, then, after a short period of drill in the shape of a few preparations containing much variation of technic, to give the student a free hand as to what he does in the way of work and we can safely allow him to develop an investigation or preparation of his own, knowing that he has at least some knowledge of the operations and (and this is important) that *his own interest is spurring him* to the exactitudes and care that are so valuable in the laboratory. This interest leads inevitably to another exercise which is desirable, yet always omitted from the laboratory text, namely, the use of the literature.

Considering once more that one year is the extent of the practice of many of the class, that the future usefulness of the practice is its justification, it seems almost obvious that a portion of the time should be employed in finding the way to approach the literature in an investigation. It is the first knowledge they will need if they have to enter the field in later years, and the knowledge is at this time easy to get under supervision and encouragement, perhaps difficult when later needed. Perhaps they may even have enough experience of it to know some of the pitfalls there for the unwary, covering thereby in the most favorable circumstances a stretch of ground that is notoriously bad in the progress of the organic chemist. While the knowledge might be deferred for those who go further with organic chemistry there seems to be no good reason for deferring it even in such a case. It seems, then, that a suitable course for the whole class would be one which involves no pretense of covering a scheme of general reactions, which does involve a short period of preparative work covering as much variation of technic as possible but not driven to any meticulous detail, which does involve the employment of the students' interest as often as possible, which encourages small investigations, gives a knowledge of an approach to the literature, and on all occasions makes appeal to the major professional interest of the student, eliminates necessity for exact repetition except in attainment of some end, encourages on all occasions an activity as nearly as possible the same as that of the practicing chemist and as nearly as possible the same as that of the future possible activities in the field, whatever their professions. This general aim obviously calls for something very different from the conventional repetition of preparations and accordingly the following changes have been made in the usual procedure. These innovations are adduced with modesty, since they are perhaps only applicable to our particular circumstances, and perhaps not as effective as some simple change in the relationship of the pupil to the university, some good choice of inspiring tutors, or other ameliorant of the learning process. Further, the results are hard to evaluate, and new systems are prolific of new errors and problems

whose bad results are not seen for a time. Nevertheless, the actions following from the preceding arguments have been taken in good faith, the principle of student interest has been thoroughly embraced at whatever cost in time and money, and the results already achieved are a partial recompense for the trouble.

The class first enters a period of preparative work, the preparations being chosen from the point of view of interest and illustration of technic rather than relationship to the theory simultaneously being taught, since this period is to end long before the theoretical course is ended. For the first month or so each laboratory period starts with a demonstration of the fundamental operations by the instructor and assistants, and with the demonstration goes a talk on the variations of the procedures, warnings, proofs, such as is possible by word of mouth while the demonstration proceeds. Thus the first experiment may well be the preparation of a well-known general article occurring in nature, of interest to the pupil and his family. Thus the preparation of caffeine from tea (brought by the student) covers some different ways of filtering, a rough titration by precipitation, a crystallization, a sublimation, and gives a chance to the student to devise an apparatus without danger of complete failure, however poor his attempt (details are furnished on pages 113–4). The drug is kept by the student. The succeeding experiments are similarly designed, avoiding exact repetition of the other operations as far as possible, and thus perhaps sacrificing the yield for the sake of experience, since this question of yield forms a lesson of its own.

After this period the more capable students are asked to suggest an inquiry of their own, the medium students to perform a little qualitative analysis, and the poorer to continue with preparations. Here and there the professor throws out hints for small inquiries, avoiding consultation with the instructor for the sake of preserving an air of spontaneity in the matter. From the preceding year there are some uncompleted inquiries: these are given for completion to the better students. Some are asked to test some recent claims of good yields in the literature, some are placed on preparations of substances in which they have evinced an interest. Most of the work is taken directly from the literature and when translations are necessary they are done by the tutors (often one of the students is capable of helping out others in this respect). The assistants and instructor and professor are considered to be always available and the times of the students are not restricted to the regular hours in any special work. As often as possible the student is brought into contact with research students in fields of their interest, and even sent around for help when this is available without such movement, all in furtherance of the feeling of working in chemistry rather than completing a course.

When the student is ready for his own work, his postulation of his ex-

periments is examined, checked or amplified, approved or condemned: every step thereof is later embodied in a report. The method of reporting is left to the student, and he is conscious of the fact that his reports are to be evaluated by the standards of the reports already in the literature, a standard high enough to call for the best in the best students. It is remarkable how careful, neat, and well written many of these reports are, in a style unspoiled by too slavish an imitation of precedent. At the end of the first semester some ten per cent of the class is doing special work, a proportion that grows to over fifty per cent by the end of the year. For those who have successfully completed some little inquiry or set of preparations from the literature embodied in a satisfactory report double maturity credits are given (a certain number of maturity credits are required in this university for completion of a degree, and the course is evaluated for a fraction of these: this fraction is doubled at the instance of the professor and instructor where deserved, as a recognition of capacity).

If a text is being used by the student (a set of texts is available in the laboratory) he is constantly being asked for his understanding thereof by his assistants, and after some months he is not allowed to work from the text in the laboratory but only from his own notes taken from the text. Laziness naturally curtails these, and evidence of intelligence and learning is found in those notes which are short of irrelevant or unnecessary details. The purpose of this barring of texts is the development of the student's own imagination concerning his materials, most texts being far too exact in detail, often even misleading in their very detail. Indeed, some mistake on the part of the student is welcomed provided it arises from lack of knowledge or experience, since it provides an opportunity for an examination of the sources of the mistake, a repetition of the experiment to avoid it, and success with gratification (provided the mistake is not too serious, done, for instance, with the whole yield of a substance to be used for further inquiry).

The pre-medical students will be found preparing various drugs, amino acids, or disinfectants (mercurochrome, tyrosine, hippuric acid on a large scale, indicators for biological work, tyramine, salol, aspirin, veronal, etc.), and some of them will test out the preparations biologically. The engineers will be found testing out autoclave reactions, electrolytic preparations, catalytic reactions, and various preparations of possible commercial value.

No attempt is made to force the choice, even if it means obtaining expensive chemicals or involves trouble and work for the stockroom or tutors. The assistants are constantly in demand for advice and find the supervision of these students on special work a continual challenge to their own capacities and an experience of value to themselves (they are usually research workers in organic chemistry). The instructor is kept busy and interested,

finding in the by-paths of the work continual surprises and points of interest for further examination. The cost is heavy, as would be expected in a scheme which embodies some of the tutorial method and virtue, but this was anticipated and will be no barrier to a further extension of a system which seems satisfactory so far, and promising for the future.

As a specific illustration of the type of experiment performed by the student the details of the preparation of caffeine from tea are given. This experiment is chosen on the grounds of interest, arranged in accordance with the principles of experience in operation rather than reaction, providing a normal first step, but easy, in the experience of a chemist working from natural sources. The magnificence of the formula is to be joked away, and, of course, not to be learned. Herein appear the use of wide-pored material for filtration of solutions colloidal in nature; filtration hot, cold, warm, and with suction; extraction with liquids heavier than water; precipitation, washing, decantation: crystallization by evaporation and sublimation under reduced pressure; reduction of bulk. This formidable list of operations is really not difficult, and in the body of a text which it is hoped to publish later the appropriate notes are included, containing the information at the time necessary, and amplified later in the further variations of the procedures.

Place the contents of a one-half pound package of tea (preferably a finer grade of Pekoe or black tea) in a two-liter round-bottomed flask (*note on the use of flasks*) and add about 1200 cc. of water. Support it on a stand and bring to gentle boiling over a wire gauze (*diagram*). Allow the digestion to proceed while a solution of basic lead acetate is prepared as follows:

> Dissolve 20 g. of lead acetate in 100 cc. of water in a beaker and add 20 g. of litharge (lead monoxide). Boil for a few minutes, stirring frequently with a rod. Filter while warm from any undissolved (*note on warm filtrations*) litharge and place the solution on the steam-bath to keep warm.

The tea infusion is now filtered from leaves by means of a porous cloth (unsized cotton cloth, linen, or cheese cloth) (*note on filtrations of such a nature*) stretched over a large beaker or wide dish in any convenient way. After removing the tea leaves, pour back the tea infusion into the clean flask and, while still warm, add the solution of basic lead acetate previously prepared, the addition to cease when no further precipitation is observed (*note on this form of titration and its employment*). Heat the mixture nearly to boiling and filter, hot; wash the precipitate once with 100 cc. of hot water, adding the washings to the filtrate (*note on hot filtrations, apparatus, diagrams, and reference to other filtration notes in the text*). Bring the filtrate once more to boiling in a large beaker and remove the excess lead by precipitation by means of dilute sulfuric acid until no further precipitate of lead sulfate appears (*further note on this form of titration, dangers, the disposal of the excess in further instructions, and note on sulfuric acid, sulfites, sulfides, in organic practice*). Allow the precipitate to settle and decant the solution away from the precipitate (*note on decantation, washing, diagrams*); alternatively, filter. (*Already an alternative is suggested.*) Boil down the solution to about 300 cc. and add 0.25 g. or less of animal charcoal or norite (*note on the use of such substances, quantity normally, particular dangers*). Continue to boil down until the volume is about 250 cc. Cool.

Filter off the animal charcoal, most conveniently using a small Buchner funnel and a filter flask at the pump (*diagrams*). Extract the filtrate three times with 50-cc. portions of chloroform in a separatory funnel running off the lower layer of chloroform in each case (*note on extractions with calculations and normal procedures*). Collect the chloroform extracts and convey them into a 250-cc. distilling flask. Attach the distilling flask to a straight-tube water condenser (*introductory note on distillations, diagram, practice*) as shown in the diagram and distil off the chloroform on the water-bath. When no more chloroform distils over detach the flask and add 50 cc. of water to the residual impure caffeine. Boil on a free flame to dissolve the caffeine (if it does not all go into solution, neglect the residue). Transfer the solution to a small dish and place the dish on the steam-bath, stirring as the water evaporates, bringing down any solid from the sides into the body of the solution as the bulk decreases. When the volume is about 10 cc., set aside to cool (*note on crystallization by evaporation*). The caffeine slowly comes out in the form of white crystals, being a mixture of anhydrous and hydrated caffeine (one mole of water) (physical properties, reactions). The caffeine is further purified by sublimation, preferably under reduced pressure (in vacuo). For such an operation a wide boiling tube is suggested as in the diagram, the caffeine being heated with a very small flame under a chimney and covered with a material to prevent the sublimed stuff from falling back on the lower part of tube (*note on sublimation, introductory theory, use*). (*Already some devising of apparatus is left to the student, the requirements being sketched, the assistants to check each set-up before commencing.*)

Justification for the inclusion of a course in Practical Organic Chemistry in the curriculum has been shown by describing an introductory course which aims at the employment of student interest for efficiency, suitable for students of diverse professions; and involves the learning of an approach to the literature, neglect of general reaction illustration, individual work and reports, with the encouragement of individual style and imagination.

New Uses Found for Helium, Former Rare Gas in Sun. Helium, first discovered in the sun and later obtained at great expense in minute laboratory quantities, is now familiar to every one as the lifting gas for American airships. Soon, however, it may be even more common for still other uses are rapidly being found for it. At the Cincinnati meeting of the American Chemical Society, R. R. Bottoms and W. E. Snyder of the Helium Co., Louisville, Ky., stated that "helium gas is now available in commercial quantities in the United States and there is sufficient supply to meet not only the needs of aeronautics, but for other uses as well."

The points that make helium valuable, they stated, are that it is inert chemically, not combining with any other element; it is very light; it is insoluble, conducts heat well and can be cooled to an extremely low temperature without liquefying. These properties, they say, make it valuable for use in metallurgy, for the preservation of food, for heating and cooling, and as a circulating medium, instead of air, in drying systems. They also suggest that it can be used as an artificial atmosphere for deep sea divers and caisson workers and for the treatment of diseases of the lung and blood. In such uses it would be employed as a substitute for ordinary air, the helium being mixed with oxygen, and thus taking the place of the nitrogen in the atmosphere.—*Science Service*

THE TEACHING LOAD OF COLLEGE CHEMISTRY INSTRUCTORS*

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The following article is a summary of an investigation made in the fall of 1929. The investigation was a survey of the teaching loads of chemistry teachers in two hundred eighty-seven liberal arts colleges. Institutions, classified by type of control and also by size of student enrolment, furnished the data.

The study shows the conditions among chemistry teachers with regard to the distribution of the teaching load among them as it existed during the school year 1929-30. It concludes with recommendations intended to suggest a more equitable distribution of such teaching load.

. . . . . .

Introduction

Statement and Definition of the Problem: This investigation is a survey of the teaching load of chemistry instructors in the liberal arts colleges and universities of the United States.

The teaching load as a survey of the instructional work of college chemistry teachers may resolve itself into the following factors:

1. The present teaching load in terms of teaching hours per week.
2. The relationship between types of courses and total teaching hours per week.
3. Percentage of instructors who must personally carry the responsibilities relative to ordering, maintaining, and furnishing supplies and equipment for student use.
4. The administrative policies governing the instructors' teaching loads with respect to:
   (*a*) Allowance for laboratory teaching or supervision in terms of teaching hours.
   (*b*) Allowance for pursuance of personal research work in terms of teaching hours.
5. Comparisons of factors one to four inclusive with respect to types of colleges—state, sectarian, private, and lastly, with respect to the size of colleges.

Limits of the Investigation: In the analysis of teaching hours, this investigation is confined specifically to the instructional work of full-time teachers. It limits the instructional work to the time actually spent with the classes in the laboratory or in the classroom in connection with chemistry courses on the college level. It is not proposed to measure or equate the variables that are not a part of the instructional hours actually spent in the classroom or in the laboratory. Furthermore, it is not proposed to measure the teaching load of instructors who have a "mixed schedule," that is, a schedule that, in addition to one or more chemistry courses, includes courses in fields other than that of chemistry.

Definition of Terms: Statements of explanation of terms are in order for a proper understanding of various terms as they are used in this survey.

* A summary of an investigation made in the fall of 1929 and embodied in a master's thesis presented in the School of Education, New York University, May, 1930.

The term *Hour* as used in the data tabulated in this survey has a weighted value. It represents the sum of lecture or recitation clock hours plus the weighted laboratory hours. The weighting of laboratory hours was determined by the questionnaire answers as to equivalence of laboratory clock hours in terms of lecture clock hours. A sample of raw questionnaire data might further clarify the term. Supposing Teacher A has a total of 10 lecture clock hours and 4 laboratory clock hours as his teaching load; the administration of his school states that 2 laboratory clock hours are equivalent to 1 lecture clock hour; then his teaching load would be 10 plus (4 divided by 2), which gives a total of 12 hours in his teaching load.

Unweighted hours of time are expressed as *Clock Hours*.

Both *Hour* and *Clock Hour*, as each is defined above, designate units spent over a period of one week.

The term *Instructor* designates any college teacher regardless of whether his title is professor, associate professor, assistant professor, or instructor.

Previous or Related Studies: Surveys of previous or related studies were made but space will not permit of their being summarized in this paper. The results were built on so many bases that it was well-nigh impossible to make any comparisons among them or to draw any conclusions from them.

Value or Significance of Investigation to Education: Previous surveys in the field of education indicate that very little has been accomplished with respect to surveying the teaching load in the field of the laboratory sciences on the college level. Chemistry as one of the sciences presents a difficulty in the matter of equating laboratory hours in terms of teaching hours. College administrations follow no standardized plan in adjusting laboratory clock hours in terms of teaching hours. Furthermore, the responsibilities with regard to the handling of laboratory supplies and equipment are often included in the duties of the instructor.

A knowledge of existing conditions in the teaching of college chemistry may lead to a better understanding on the part of college administrators and chemistry instructors.

Collection of Data

Method of Conducting Investigation: In order to make a survey of factual conditions as they actually exist with respect to teaching chemistry in the liberal arts colleges and universities of the United States, it was necessary to secure specific information from at least a representative sampling of all institutions concerned. The written questionnaire method was the only means practicable in such an undertaking. Thus a printed questionnaire with a letter of explanation to accompany it, was sent to the head of the department of chemistry in each liberal arts college and

university in the United States. A total of five hundred seventy* colleges were included in the list to which the questionnaire was sent.

Analysis of Questionnaire Make-Up: The questionnaire itself had three subdivisions—Parts I, II, and III. Part I had space for itemized time expenditures in class or laboratory by a maximum of four teachers. It also provided space for itemized time expenditures of student or graduate assistants. Such student or graduate assistants were listed as definitely assisting one of the teachers listed previously. The listing of hours for each instructor might be entirely under one course or scattered among two or more courses. There were five courses under which a listing of hours could be made. These courses were considered as representative of the chemistry courses given in college on the undergraduate level.

Part II, in so far as the first four questions were concerned, required yes or no answers with respect to the handling of laboratory equipment and supplies. The fifth question called for opinions from heads of chemistry departments as to what they considered a fair teaching load in clock hours per week.

Administration policies were ascertained in Part III. Question one asked for value of laboratory teaching or supervision in terms of lecture hours. The answers here were absolutely necessary in equating laboratory hours, listed under Part I, in terms of lecture hours. Question two asked for the policy of assigning teaching loads to instructors who are pursuing personal research work.

Questionnaire Returns: Of the five hundred seventy colleges to which questionnaires were sent, the chemistry chairmen in two hundred eighty-seven returned the questionnaires completely answered.

It is on the basis of the two hundred eighty-seven questionnaire returns that the analyses, correlations, summaries, and conclusions have been made in the following pages.

In these pages no attempt will be made to identify data with specific colleges and universities other than with those of the same type or size. In fact a pledge of no publicity to the schools giving questionnaire returns prevents specific attention being focused on any particular institution.

Presentation and Analysis of Questionnaire Returns

In a questionnaire involving as many and varied factual answers as in the questionnaire about which this investigation revolves, an attempt must be made to separate it systematically into divisions. Especially Part I of the questionnaire needs a scheme of classification.

* These five hundred seventy colleges represented all liberal arts colleges and universities that were known to have teachers presenting chemistry courses. To eliminate involved variables, normal colleges, teachers' colleges, and colleges primarily for negro students were omitted from the list. Addresses of available colleges and universities were obtained from Hurt's College Blue Book, 1928 edition.

First, the teaching hours, to be designated by the term *Hour*, were classified to show the relationship between the total hours and the hours spent in one course. Second, the colleges were divided with respect to type of administrative control, namely, state, sectarian, private, and non-sectarian. Third, the colleges were divided with respect to size of student enrolment, namely, less than 400, 400 to 1000, 1000 to 2000, and lastly, those with 2000 or more.

The courses analyzed were general chemistry, qualitative analysis, quantitative analysis, organic chemistry, and physical chemistry.

TABLE I

Summary of Total Teaching Loads with One or More Hours of General Chemistry in the Total Loads

Type of Institution	*Number of Cases*	*Median (Hours)*	*Mode (Hours)*	*Quartile Deviation (Hours)*	*Range (Hours)*	*Teacher Distribution as to Teaching Load (%)*			
						8–10 (Hours)	*11–13 (Hours)*	*14–16 (Hours)*	*17 and Up (Hours)*
State-controlled	71	13.64	15.5	2.30	8–20	22	32	32	14
Sectarian	220	14.58	13.5	2.15	8–27	13	30	34	23
Private non-sectarian	91	13.06	12.5	2.68	8–24	25	34	21	20
Up to 400 enrolment	79	13.92	13.5	2.17	8–27	18	33	30	19
400 to 1000 enrolment	196	14.84	12.5	2.57	8–27	15	29	28.6	27.4
1000 to 2000 enrolment	57	13.91	11.5	2.70	8–20	18	33	24.5	24.5
2000 and up enrolment	50	14.07	12.5	1.77	8–20	15.5	33	37	14.5
All colleges	382	13.97	13.0	2.34	8–27	17	32	30	21

TABLE II

Summary of Total Teaching Loads with One or More Hours of Qualitative Analysis in the Total Loads

Type of Institution	*Number of Cases*	*Median (Hours)*	*Mode (Hours)*	*Quartile Deviation (Hours)*	*Range (Hours)*	*Teacher Distribution as to Teaching Load (%)*			
						8–10 (Hours)	*11–13 (Hours)*	*14–16 (Hours)*	*17 and Up (Hours)*
State-controlled	26	15.6	16.5	1.94	8–21	12	23	38	27
Sectarian	131	14.59	14.5	2.31	8–27	12	31	29	28
Private non-sectarian	57	13.91	12.5	2.44	8–23	19	32	30	19
Up to 400 enrolment	60	14.21	13.5	2.32	8–27	9	38	30	23
400 to 1000 enrolment	104	14.66	15.0	2.5	8–24	14	28	36	22
1000 to 2000 enrolment	25	14.25	11.5	2.94	8–20	12	36	16	36
2000 and up enrolment	25	15.0	14.25	1.75	8–21	14	27	41	18
All colleges	214	14.61	14.0	2.3	8–27	13	31	32	24

Summary of Total Teaching Loads with Various Types of Courses Involved in the Total Load: The following tables are included in order to summarize the central tendencies and the distribution of hours when various courses are involved in the total teaching load.

TABLE III

Summary of Total Teaching Loads with One or More Hours of Quantitative Analysis in the Total Loads

Type of Institution	*Number of Cases*	*Median (Hours)*	*Mode (Hours)*	*Quartile Deviation (Hours)*	*Range (Hours)*	*Teacher Distribution as to Teaching Load (%)*			
						8–10 (Hours)	*11–13 (Hours)*	*14–16 (Hours)*	*17 and Up (Hours)*
State-controlled	27	14.5	8.5	3.56	8–20	33	15	33	19
Sectarian	102	14.4	14.5	2.62	8–25	13	31	25	31
Private non-sectarian	49	14.5	12.5	2.07	8–23	10	35	31	24
Up to 400 enrolment	35	14.16	13.5	1.95	8–21	9	40	30	21
400 to 1000 enrolment	93	14.61	12.5	2.89	8–25	15	29	22	34
1000 to 2000 enrolment	27	13.88	11.5	2.81	8–20	15	37	18	30
2000 and up enrolment	23	14.66	14.5	1.75	8–20	20	10	55	15
All colleges	178	14.4	12.5	2.55	8–25	14	31	27	28

TABLE IV

Summary of Total Teaching Loads with One or More Hours of Physical Chemistry in the Total Loads

Type of Institution	*Number of Cases*	*Median (Hours)*	*Mode (Hours)*	*Quartile Deviation (Hours)*	*Range (Hours)*	*Teacher Distribution as to Teaching Load (%)*			
						8–10 (Hours)	*11–13 (Hours)*	*14–16 (Hours)*	*17 and Up (Hours)*
State-controlled	27	12.5	11.5	2.44	8–21	26	37	15	22
Sectarian	95	14.19	13.5	1.69	8–24	15	33	31	21
Private non-sectarian	31	13.12	11.5	2.06	8–20	22	39	26	13
Up to 400 enrolment	22	13.35	13.5	2.44	8–18	33	38	24	5
400 to 1000 enrolment	78	14.5	13.5	2.63	8–24	12	33	31	24
1000 to 2000 enrolment	29	14.17	15.5	2.57	8–20	24	24	35	17
2000 and up enrolment	24	13.0	12.5	2.13	8–21	9	45	23	23
All colleges	153	13.51	13.0	2.25	8–24	16	35	28	21

In the 8- to 10-hour total teaching load group, the number of instructors having general chemistry as part of their load shows a slightly larger percentage than do any other groups.

Of the instructors giving quantitative analysis, an unusually large percentage has teaching loads in excess of 16 hours. In fact, almost one-

TABLE V

Summary of Total Teaching Loads with One or More Hours of Organic Chemistry in the Total Loads

Type of Institution	*Number of Cases*	*Median (Hours)*	*Mode (Hours)*	*Quartile Deviation (Hours)*	*Range (Hours)*	*Teacher Distribution as to Teaching Load (%)*			
						8–10 (Hours)	*11–13 (Hours)*	*14–16 (Hours)*	*17 and Up (Hours)*
State-controlled	35	14.5	15.6	1.82	8–21	12	33	40	15
Sectarian	151	14.43	13.5	2.06	8–25	13	32	26	29
Private non-sectarian	61	13.2	12.5	2.00	8–24	18	39	25	18
Up to 400 enrolment	63	13.87	13.5	2.31	8–20	18	35	25	22
400 to 1000 enrolment	131	14.39	12.5	2.06	8–25	14	34	26	26
1000 to 2000 enrolment	29	14.62	12.5	2.32	8–20	17	24	31	28
2000 and up enrolment	24	12.75	12.87	1.75	8–21	17	45	29	9
All colleges	247	13.98	12.37	2.03	8–25	14	35	27	24

third of the instructors in quantitative analysis is in this group. Is quantitative analysis considered the easiest to teach? Is the large teaching load due to many laboratory periods? Or is it a mere coincidence?

The percentage of instructors with teaching loads from 11 to 16 hours, inclusive, is fairly constant regardless of the courses included.

And finally, 21 to 28 per cent of all college teachers of chemistry have teaching loads in excess of 16 hours, the maximum load in the rulings of the associations of colleges.

Summary of Assistance with Relation to Total Teaching Load: Considering all colleges regardless of type or size, 50 per cent of the instructors had assistance, the greatest frequency being four or eight clock hours per week.

Again, the instructors in all colleges with teaching loads of thirteen teaching hours were the ones who most frequently had assistance. Evidently, high teaching loads are not lightened by the giving of assistance.

Laboratory Equipment and Supplies

The summaries to the answers on the supply and equipment responsibilities are given in Table VI.

The outstanding general trend to be noted in the above table is the fact that as larger and larger schools are viewed, equipment and supplies become more and more an impersonal matter to the teaching staff.

Administration Policies

Weighting of Laboratory Hours: The answers to the question of weighting laboratory clock hours in terms of teaching hours are summarized in Table VII.

TABLE VI

Supply and Equipment Responsibilities

Type of Institution	*Does Instructor Bring Out Materials and Set Up the Apparatus for His Lecture Table Demonstrations?*			*Does Instructor Bring Out Materials for Students' Experiments?*			*Are Students' Stockroom Demands Supplied by the Instructor Personally?*			*Are Stockroom Accounts Handled by an Instructor in Addition to a Full Teaching Load?*		
	% Yes	% No	% Partially	% Yes	% No	% Partially	% Yes	% No	% Partially	% Yes	% No	% Partially
State-controlled	44	53	3	19	78	3	9	78	13	26	74	0
Sectarian	68	28	4	42	5	53	39	54	7	60	35	5
Private non-sectarian	55	35	10	17	75	8	22	70	8	51	42	7
Up to 400 enrolment	71	25	4	51	48	1	43	47	10	64	33	3
400 to 1000 enrolment	71	28	1	36	57	7	36	56	8	60	35	5
1000 to 2000 enrolment	38	43	19	15	73	12	15	76	9	37	56	7
2000 and up enrolment	28	58	14	3	97	0	0	97	3	12	85	3
All colleges	62	33	5	34	61	5	31	61	8	52	41	7

TABLE VII

Colleges Grouped by Percentage According to Number of Clock Hours of Laboratory Supervision Equivalent to One Clock Hour of Lecture Teaching

Colleges	*Clock Hours of Laboratory Supervision Equivalent to One Hour Lecture Teaching*					
	½	1	1½	2	2½	3
By Type:						
State		16	13	39	6	26
Sectarian		6	4	60	10	20
Private	1.5	14	3	66	1.5	14
By Enrolment:						
Less than 400		12	4	60	4	20
400 to 1000	1	6	4	60	12	17
1000 to 2000		6	12	55	3	24
2000 or more		22	4	51	4	19
All colleges	0.4	9	6	59	6	20

The outstanding conclusion derived from Table VII is the fact that three-fifths of all colleges have designated two clock hours of laboratory supervision as equivalent to one teaching hour. The two-hour equivalent is apparently the standard equivalent, since the equivalents in all other colleges combined are used by only two-fifths of the colleges.

Teaching Load and Research: The position of research in the teaching load is summarized in Table VIII.

Table VIII indicates that more than one-half of the colleges give no reduction of teaching load because of research work.

TABLE VIII

Colleges Grouped by Percentage According to Answers to Question: Is a Reduction of Hours Allowed to an Instructor Who Is Doing Research Work and Nearing the Completion of Requirements for an Advanced Degree?

College	*No Answer*	*Does Not Apply**	*Yes*	*No*
By Type:				
State	12.5	0	22	65.5
Sectarian	16	6	18	60
Private	14	20	18	48
By Enrolment:				
Less than 400	16	12	15	57
400 to 1000	18	5	13	64
1000 to 2000	9	9	30	52
2000 or more	7	14	34	45
All colleges	15	10	19	56

* The phrase, *does not apply*, was used to designate replies stating that there were no opportunities for research at an institution or that there was no person to whom the question might apply.

Of the colleges giving reduction of hours on account of research work, it is apparent from the table that the larger the college, the greater is the possibility of such allowance being made.

Conclusions

I. SUMMARY

A. Teaching Load in Terms of Teaching Hours per Week

1. Slightly over one-third of all college chemistry instructors have teaching loads of 11 to 13 hours, inclusive, per week.
2. Over three-fifths of all college chemistry instructors have teaching loads of 11 to 16 hours, inclusive, per week.
3. *One-fifth of all college chemistry instructors have teaching loads in excess of 16 hours per week.*
4. Considering colleges by type of control, the state-controlled colleges have the largest percentage of low teaching loads, that is, teaching loads from 8 to 10 hours, inclusive, per week.
5. The sectarian-controlled colleges have the smallest percentage of low teaching loads, that is, teaching loads from 8 to 10 hours, inclusive, per week.
6. The non-sectarian and privately controlled colleges have the smallest percentage of teaching loads in excess of 16 hours per week.
7. The state-controlled colleges have a percentage of instructors with teaching loads in excess of 16 hours, that is, slightly larger than twenty-one per cent, the average of all colleges.

8. Considering colleges by size, the colleges with less than four hundred students have the largest percentage of low teaching loads, that is, teaching loads from 8 to 10 hours, inclusive, per week. This same group of colleges has also the smallest percentage of teaching loads in excess of 16 hours per week.
9. The very large colleges, that is, the colleges with two thousand or more students, have the smallest percentage of very low teaching loads, that is, loads from 8 to 10 hours per week.
10. The colleges with enrolments of four hundred to one thousand students have the largest percentage of teaching loads in excess of 16 hours per week. Their percentage is three per cent over the average for all colleges.
11. The colleges with enrolments of two thousand or more show a high percentage of instructors with teaching loads between 11 and 13 hours, inclusive, per week. This percentage is one-third larger than the average for all colleges.

B. Types of Courses and Total Teaching Load

1. Of all chemistry instructors, those with one or more hours of general chemistry included in the total load make up the largest percentage of those with very low teaching loads, that is, loads from 8 to 10 hours, inclusive, per week.
2. Of all chemistry instructors, those with one or more hours of qualitative analysis included in the total load constitute the smallest percentage of those with very low teaching loads, that is, loads from 8 to 10 hours, inclusive, per week.
3. Of all chemistry instructors, those with one or more hours of either general chemistry or physical chemistry included in the total loads compose the smallest percentage of those with loads in excess of 16 hours per week.

C. Relationship of Clock Hours of Assistance to Total Load

1. Only in the case of general chemistry teaching is the nature of assistance uniform enough to permit comparison of teaching assistance in various colleges.
2. About fifty per cent of all instructors who have general chemistry in the total teaching load have assistance.
3. In state- and sectarian-controlled colleges, instructors with teaching loads ranging from 9 to 13 hours, inclusive, are most likely to have assistance.
4. The assistance in state-controlled colleges is most frequently either 8 or 12 clock hours per week.
5. The assistance in sectarian-controlled colleges is most frequently either 4 or 8 clock hours per week.

6. In private or non-sectarian colleges, instructors with teaching loads ranging from 9 to 15 hours, inclusive, are most likely to have assistance.
7. From the point of view of college enrolment, the instructors in very small schools most frequently have 4 clock hours of assistance per week.
8. In the four hundred to one thousand enrolment group, the instructors most frequently have 4 or 8 clock hours of assistance per week.
9. Considering colleges as a whole, instructors with total teaching loads of 13 hours most frequently have assistance.
10. Instructors with high or excessive teaching loads are not given assistance.

D. Opinions of Heads of Chemistry Departments with Respect to Teaching Loads in the Department

1. Heads of chemistry departments most frequently believe that the teaching load should average 15 clock hours per week.
2. Heads of chemistry departments most frequently believe that the laboratory clock hours of teaching are about one-half of the total clock hours of teaching.
3. If two clock hours of laboratory teaching are equivalent to one clock hour of lecture or recitation teaching, then 15 clock hours total load with half time in the laboratory equals 11.25 teaching hours per week.
4. Considering 11.25 hours as an average load, this is equal to the load of only one-fifth of all college chemistry instructors in the liberal arts colleges and is *from 2 to 6 or more hours below the actual load of two-thirds of all college chemistry instructors.*

E. Instructors' Responsibilities with Respect to Equipment and Materials

1. Two-thirds of all chemistry instructors set up and carry out their own demonstration experiments.
2. One-third of all college chemistry instructors bring material and apparatus into the laboratory where it is accessible to the students performing the experiments.
3. One-third of all college chemistry instructors personally supply the students' demands on the stockroom.
4. The stockroom accounts in two-thirds of the small colleges are handled by one of the instructors in addition to a full teaching load.
5. The stockroom accounts in only one-eighth of the very large colleges are handled by one of the instructors in addition to a full teaching load.

F. Administration Policies

(*a*) *Laboratory hours in terms of teaching hours*

1. Three-fifths of all colleges have designated two clock hours of laboratory supervision or teaching as equivalent to one teaching hour.
2. Twenty-nine per cent of all state-controlled colleges designate less than two clock hours of supervision or teaching as equivalent to one teaching hour.
3. At the same time, the state-controlled colleges show the largest percentage of all colleges in designating more than two clock hours of laboratory supervision or teaching as equivalent to one teaching hour.

(*b*) *Allowance for research work*

1. Fifty-six per cent of all colleges give no reduction of hours on account of research work. This percentage may not be significant since many teaching loads may be low enough to permit time for research work without requiring a reduction of teaching hours.
2. The larger the college, the greater seems to be the tendency to give a reduction of teaching hours on account of personal research work.

II. Limitations in Conclusions

The conclusions offered in this survey investigation may have certain limitations.

1. The data are records of the 1929 fall semester's conditions in the liberal arts colleges of the United States and may or may not be an analysis of a normal period.
2. The variables exclusive of time spent with the students* have not in any way been computed or weighted with classroom work.
3. The 51.4 per cent questionnaire returns are uniformly representative of colleges by type and size, but need not necessarily be representative of all the colleges.

III. Recommendations

A. Teaching Load

1. Since four-fifths of all instructors of college chemistry have teaching loads of 16 hours or less per week and if 16 hours or less are considered capacity loads, then *one-fifth of all college chemistry instructors are either overworked or not conducting the teaching with average efficiency.* Colleges would do well to investigate all situations in chemistry where there are teaching loads in excess of 16 hours per week.

* See references 3 and 13 in bibliography at end of article.

2. College accrediting agencies have stipulated that 16 hours per week shall be the maximum teaching load in any department. Many of the instructors who have loads in excess of 16 hours are teaching in colleges recognized by one or more college accrediting agencies. If the accrediting agencies' rules on maximum teaching load are meant to apply to all recognized colleges, then such agencies may profitably investigate the size of chemistry teaching loads in colleges already recognized.
3. If the college accrediting agencies' rules on teaching load are to be applied to colleges seeking recognition by the agencies, then such agencies need to investigate very carefully the chemistry teaching loads in such colleges.

B. Material and Equipment Responsibilities

One-third to two-thirds of all chemistry instructors personally maintain and distribute all laboratory equipment and materials. The burden of this work should be lightened by the assignment of fewer teaching hours to such instructors. Then the demands on such instructors would be more equalized with the demands on those who teach courses involving no responsibilities of equipment or materials.

The assignment of teaching loads to college chemistry instructors requires reflective thinking in terms of clock hours in the classroom, laboratory, and stockroom rather than in terms of teaching hours.

Bibliography

1. ASSOCIATION OF LAND-GRANT COLLEGES, SECTION OF HOME ECONOMICS, "Report of the Committee on Teaching Load," *Proceedings*, **1923**, 430–4.
2. CRAWFORD, CLAUDE C., "The Techniques of Research in Education," University of Southern California Press, Los Angeles, **1928.**
3. DAVIS, CALVIN O., "The Teaching Load in a University," *Sch. & Soc.*, **19**, 556–8 (May 10, 1924).
4. FREED, WILLIAM J., "A Study of the Salaries and Teaching Loads in Denominational 4-Year Colleges and Private Junior Colleges in United States," The Pioneer, Inc., Tacoma, Washington, **1929.**
5. GOOD, CARTER V., "How to Do Research in Education," Warwick and York, Baltimore, **1928.**
6. HEILMAN, JOHN D., "Methods of Reporting College Teacher's Load and Administrative Efficiency," *Educ. Admin. Superv.*, **2**, 167–87 (March, 1925).
7. HURT, HUBER WILLIAM, "The College Blue Book" (second edition). The College Blue Book Press, Hollywood-by-the-Sea, Florida, **1928.**
8. INDIANA, "Report of the Survey Commission of Higher Education," Report of a Survey of the State Institutions of Higher Learning in Indiana. Indianapolis: W. B. Burford, contractor for state printing and binding, **1926**, pp. 97–107.
9. KOOS, LEONARD V., "The Adjustment of the Teaching Load in a University," *Bureau of Education Bulletin*, No. 15, 1919. Washington: Government Printing Office, 63 pp. This bulletin is now out of print.

10. NORTH CENTRAL ASSOCIATION OF COLLEGES AND SECONDARY SCHOOLS, "Report of the Committee on Teaching Load in Colleges," *North Cent. Assoc. Quart.*, **4,** 250–9 (September, 1929).
11. POOLE, MARY E., "An Experimental Measurement of the University Load on Total Time Consumed," American Association of Collegiate Registrars, *Bulletin N. S. L.* 114–31, July, **1925.**
12. REEDER, WARD G., "How to Write a Thesis," Public School Publishing Company, Bloomington, Illinois, **1925.**
13. SWEENY, MARY E., "What Constitutes a Teaching Load?" Association of Land-Grant Colleges, *Proceedings*, **1922,** 303–7.
14. TEXAS EDUCATIONAL SURVEY COMMISSION, "Texas Educational Survey Report, Higher Education," **1925,** pp. 200–11.

Ice Made under Pressure Warms Instead of Cools. Dr. P. W. Bridgman of Harvard University has frozen water at a temperature of 180 degrees Fahrenheit, only 42 degrees below its boiling point. His product is ice as real as that which forms on ponds in the winter; but it is hot ice, so hot that it will burn one's hands.

It was made by putting water under a pressure of 290,000 pounds or 145 tons per square inch. Ordinary ice becomes unstable at pressures greater than 29,000 pounds per square inch and is replaced by other forms, one of which is stable at 290,000 pounds and temperatures as high as 180 degrees, Dr. Bridgman found.

He has conducted experiments with pressures as high as 580,000 pounds or 290 tons per square inch. Many interesting changes in the properties of substances take place under these unusual conditions.

Pressures of more than half a million pounds per square inch are meaningless until compared with atmospheric pressure of slightly less than 15 pounds, the pressure in steam boilers which seldom exceeds 1200 pounds, or the pressure at the bottom of the deepest part of the Pacific ocean which is little more than 15,000 pounds per square inch.—*Science Service*

Dyes Made from Castor Oil. Castor oil as a thing of joy and beauty is the promise held in recent experiments in the manufacture of dyes from fat, conducted by Rajendra N. Sen and Ashutosh Mukherji, in the chemical laboratory of the Presidency College, Calcutta. From castor oil was obtained a brown powder which gave an orange tint to wool and silk. Coconut oil was also tried and yielded a brighter orange color, while olive oil made a brown dye for wools and stained silks in various shades of red. The method used in the manufacture of the new dye was developed by Mr. Sen. It consists in using esters of benzoic, salicylic, and other acids instead of the acids themselves in the process. Chemically, fats are also esters, although they are quite different from the simpler esters of benzoic and salicylic acids.

High yields obtained in the laboratory and the ease with which the dyes may be manufactured from fats suggests that the new process will be of commercial importance. Oil fats have an advantage over coal tar, now widely used in dye making, in that the supply is continually replenished by nature, in the tropics or on farms and plantations. Hence there is no danger of exhausting the supply, even in the remote future. Also, many of the oils can be obtained at a much lower price than ordinary dye materials.—*Science Service*

VISUAL AIDS IN CHEMICAL EDUCATION*

V. Slides Available for Use in Chemistry Classes

The stereopticon slide has a place among the various aids for the presentation of chemical knowledge. Like every other means which may be taken to elucidate a specific problem, the slide may be misinterpreted, misused, and abused. The usual tools of the chemist are subject to the same possibilities. A boy, for example, may become so absorbed with the violence of explosions in an experiment that he utterly fails to comprehend the chemical significance involved. Every teacher has met with that experience and has taken the necessary steps to direct the student's attention through the realms of relative unimportance to the fundamental idea.

For the chemist as well as for every science instructor, the problem of additional tools brings additional problems in the technic of presentation. The projection of still or motion pictures without technic is of little value. The introduction of such pictures has increased the potentials in the hands of the teacher. His question is now, "What agency or combination of all these agencies at my command are the most desirable for the given point under consideration?"

In the following list of sources of slide material in chemistry subjects, the Committee on Visual Aids in Chemical Education does not feel that a thorough study of the field has been made. It is given here as a beginning and with the hope that teachers and friends will keep the Committee posted on both subject material and sources which may be added to supplementary and revised lists which the Committee will publish from time to time.

Chemistry teachers who wish to use slide material will do well to get in touch with the visual instruction divisions of their state departments of education or state universities, many of whom have slide material in chemistry subjects which is loaned either free or at a small cost in addition to express charges to the user.

Sources of Slide Material

Appropriate lecture material accompanies those slides marked #.

BRAY SCREEN PRODUCTS FILM LIBRARY, 130 West 46th Street, New York City

Film Slides—Sale only

Subject	*No. of Pictures in Set*	*Approximate Cost to Buyer*
Petroleum and Gas	1 Roll—50 frames	$3.00
Ice and Refrigeration	1 Roll—40 frames	3.00
Set of Science of Life	12 Rolls	30.00
Set of Human Body	6 Rolls	18.00
Set of General Science	12 Rolls	30.00

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* This is the fifth of a series of articles from the Committee of the Division of Chemical Education of the A. C. S. on Visual Aids in Chemical Education. See J. CHEM. EDUC., **7**, 828–33, 1113–4, 1341–8, 2916–27 (1930).

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#Building Stone	50
#Coal—Anthracite	51
#Coal—Bituminous	52
#Concrete	22
#Glass	40
#Gold	30
#Iron	24
#Marble	29
#Paper	37
#Petroleum	43
#Pottery	25
#Rubber	53
#Silk—Japan	20
#Silk—U. S.	26
#Some By-Products of the Meat Packing Industry	47
#Steel	60
#Tile	33
Story of Coal, Part 1	103
Story of Coal, Part 2	74
Story of Copper	89
Iron and Steel	78
Story of Marble	86
Manufacture of Paper	110
Petroleum and Gas	98
Story of Salt	83
Story of Silk	103
Ice and Refrigeration	100
Building Stone	103

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Story of Cotton Growing, Part I	71
Story of Cotton Growing, Part II	83
Iron and Steel	78
Story of Marble	86
Manufacture of Paper	110
Petroleum and Gas	98
Story of Salt	83
Ice and Refrigeration	100
Building Stone	103

No manual necessary as captions are on films.

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Film Slides—Sale only—Approximate cost $3.00 each

Subject	No. of Pictures in Set
#Brick	23
#Building Stone	50
#Coal—Anthracite	51
#Coal—Bituminous	52
#Concrete	22
#Cotton Production	36
#Cotton Manufacture	30
#Dairying	61
#Flax and Linen	48
#Flour Milling	23
#Glass	40
#Gold	30
#Irrigation	24
#Iron	24
#Lumbering	44
#Marble	29
#Paper	37
#Petroleum	43
#Pottery	25
#Rubber	53
#Salt	32
#Silk—Japan	20
#Silk—U. S.	26
#Some By-Products of the Meat-Packing Industry	47
#Steel	60
#Sugar-Beet	36
#Sugar-Cane	40
#Sugar, Maple	20
#Tile	33
#Wool Production	21
#Wool Manufacture	33

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Marble Production in Vermont	15
Petroleum	15
Petroleum—A—Production	15
Petroleum—B—Refining and Marketing	16
Rubber	16
Soap Making	42
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Tire Manufacturing—B	15

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Clay and Clay Products	60
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Forest Conservation	65
Improvement of the Dairy Herd	56

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#Anthracite Coal Mining	120
#Same—Shorter version	44

U. S. DEPARTMENT OF AGRICULTURE, Washington, D. C.

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Production of Clean Milk	45	.35

VISUAL TEXT SALES COMPANY, 1890 Crenshaw Blvd., Los Angeles, Calif.

Film Slides—Sale only—approximate cost $3.00 each

Subject	No. of Pictures in Set
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Air, Part II, Nitrogen and Carbon Dioxide	60
Air, Part III, Characteristics of the Air	61

W. M. WELCH SCIENTIFIC COMPANY, 1516 Orleans Street, Chicago, Ill.

Glass Slides—Sale only—approximate cost $0.85 each

Subject	No. of Pictures in Set
Introduction to Chemistry	8
Oxygen	16
Hydrogen	10
Water	17
Nitrogen	21
Elements of the Nitrogen Group	10
The Halogens	9
Carbon	28
Flame and Liquid Fuels	12
Atoms and Molecules	15
Crystal Systems	7
Chlorine	11
Sodium and Potassium	8
Sulfur and Sulfides	8
Silicon and Boron	13
Calcium	17
Magnesium, Zinc, and Mercury	3
Iron and Steel	13
Copper	6
Gold and Silver	9
Aluminum and Compounds	8
Tin and Lead	8
Brick	4

Subject	No. of Pictures in Set	Subject	No. of Pictures in Set
Fertilizers	6	Rubber	10
Glass	5	Salt	12
Gas Mantles	4	Soap	7
Paper	11	Sugar and Glucose	13
Petroleum	3		

FILMS AVAILABLE FOR USE IN CHEMISTRY CLASSES

In the December, 1930, number of the JOURNAL OF CHEMICAL EDUCATION appeared the fourth of a series of articles by the Committee on Visual Aids in Chemical Education of the Division of Chemical Education of the A. C. S. (pp. 2916–27). In the headings of the list of films (see page 2919) the following abbreviations were used: Saf., Inf., 16, 35. The "Saf." and "Inf." refer to safety film and inflammable film, respectively. The "16" and "35" refer to mm. width of film.

Users of the 16-mm. motion picture films will find a very useful book in the "Directory of Film Sources," which gives a complete list of places to "buy, rent, or borrow 16-mm. films." This booklet will be furnished free by the Victor Animatograph Corporation, Davenport, Iowa.

English Ride on Rubber Bricks. In some parts of Great Britain the streets are now paved with rubber bricks. In a report to the recent Sixth International Road Congress at Washington, a British delegation told of the success that rubber paving has had in London, Newcastle, Edinburgh, and Glasgow.

The first experiments to substitute rubber for brick and asphalt were made in 1913, it is stated. A rubber pavement in Glasgow, consisting of blocks of rubber $9 \times 4^1/_2 \times 1^1/_2$ inches, was laid on a concrete base in 1923. "Traffic in Glasgow is some of the heaviest and most trying class," the report states. "The cap of one block came away from its tread in 1925, this is the only defect reported. The paving is in good condition and shows no apparent wear after six years' use."

An installation in London was in New Bridge Street, which bears some of the city's heaviest traffic, with 17,623 vehicles, or 51,100 tons between 8 A.M. and 8 P.M., in addition to considerable night traffic. This was laid in 1926. "After two years of wear, 416 blocks, or say four per cent were renewed, and now at the end of the third year approximately another ten per cent have to be renewed," the report states. "The defects are in the nature of blisters and the subsequent peeling off of thin layers of the cap where blisters appeared. The layers stripped off in no case extend the full surface of a block and are about one-fifth of an inch thick; the defects cause no inconvenience to traffic, but they collect dirt and are a blemish."

The paving costs about $22.00 a square yard, laid without foundation, it is stated.—*Science Service*

CHEMISTRY LABORATORY FEES

V. F. Payne and Lyda May Smiley, Transylvania College, Lexington, Kentucky

The wisdom of special laboratory fees for the sciences is questioned. The practice of 319 public and private colleges and universities with respect to chemistry laboratory fee charges is considered. The various fees per course and per credit for the fundamental courses, general chemistry, qualitative analysis, organic chemistry, and physical chemistry are tabulated and summarized. The variety and range of fees are very great. No general and uniform philosophy of assigning chemistry fees and deposits is discernible.

. . . . . .

Our various systems of charges for science laboratory courses have grown up to fit local needs and in some accord with the previous experience of those in charge. Originally, the privilege of working in a laboratory had to be justified by the willingness on the part of the student to bear the expense involved. This idea was so firmly fixed that the coming of so-called free and public universities has not been completely able to make science laboratory courses free even to the same extent that other courses are free.

Now that the sciences are a recognized part of the college curriculum, and a definite requirement in many instances, a higher charge for them may well be questioned. The undoubted contribution of the sciences to society may well justify any encouragement to their study offered by a student charge no higher than that for other courses.

Some attention has been paid to the problem of general college and university fees, but special science laboratory fees have generally gone unquestioned. One author (*1*) calls attention to the fact that in forty-four institutions studied, thirteen general plans of charging laboratory fees in home economics were followed. The term fees ranged from $2.50 to $6.00; semester fees from $3.50 to $14.00 and fees per credit from $1.00 to $1.50 plus a flat semester fee of $2.00. This writer concludes that a fee large enough to meet all the expense would keep students from electing the home economics course, and would make the teacher cut down on materials used in courses, hence lowering the educational value. Since all college courses demand expense beyond the teacher's salary and general upkeep, he recommends charging a uniform fee per credit, regardless of whether the course is laboratory or lecture, or a tuition fee to cover the expense of all courses. Either of these plans, he believes, would result in more students becoming interested in the home economics and particularly food courses.

In a chapter on "Cost Studies" Reeves and Russell (*2*) call attention to the comparative effect of extra fees paid in science courses. In twenty-six departments of one college the average salary cost per student-credit-hour is $7.10 and the average current cost per student-credit-hour is $13.17. Table I is adapted from this study.

TABLE I

Reduction in Current Cost per Student-Credit-Hour Due to Laboratory Fees Paid for Laboratory Sciences

Department	*Salary Cost per Student-Credit-Hour*	*Current Cost per Student-Credit-Hour*	*Current Cost per Student-Credit-Hour Less Fees*	*Fees Paid per Student-Credit-Hour*
Chemistry	$ 6.18	$15.09	$12.88	$2.21
Biology	6.37	14.60	13.67	.93
Physics	11.42	21.08	20.22	.86
Geology	16.68	21.62	20.95	.67
Home Economics	17.52	25.29	24.69	.60
Agriculture	20.79	26.44	26.11	.33
. . . . .				
Average All Courses	7.10	13.17		

The first line of Table I should be read: in the chemistry department of this institution the salary cost per student-credit-hour is $6.18; the current cost less fees, $12.88, and fee paid per student-credit-hour is $2.21. It would seem difficult to justify a special fee in chemistry representing 14.6 per cent of the current cost in comparison with a special fee representing 1.2 per cent of the current cost in agriculture. This seems clearly a case of attempting to popularize an expensive course. The extra bookkeeping and office work involved in collecting the latter fee may absorb much of it, and illustrate still further the inconsistency of the practice. It may be seen that a large proportion of the cost of the more expensive courses is due to salary cost. This large salary cost will be involved in any departments with very small classes, science or otherwise.

The catalogs of 319 public and private colleges and universities ranging in size from the largest to the smallest with a median size of 621 students furnished the data on chemistry laboratory fees here reported for the first time. The median general semester fee charged in these institutions is $75.00. A semester fee of $50.00 is charged by 12.6 per cent of the institutions, $75.00 by 13.9 per cent, $100.00 by 11.3 per cent, $125.00 by 9.2 per cent. The remainder charged general fees ranging from nothing to $325.00 per semester. Thirty-eight institutions, representing 11.9 per cent of the 319 studied, charged no separate laboratory fees for chemistry.

Table II gives the chemistry laboratory fees per semester course for general chemistry, qualitative analysis, quantitative analysis, organic and physical chemistry. For example, this table shows that a fee of $5.00 is the mode for general chemistry, qualitative analysis, and quantitative analysis, representing respectively 50, or 20.3 per cent of the cases; 45, or 18.6 per cent; 34, or 15.7 per cent for these courses. Twenty-one institutions charge no fee and the same number charge a fee of $6.00 for physical chemistry. This same fee represents 33, or 14.1 per cent of the

cases in organic chemistry, while the mode for this course is a fee of $10.00 represented by 37, or 15.7 per cent of the cases. The median fee charged in general and physical chemistry is $6.00, in qualitative and quantitative

TABLE II

Chemistry Laboratory Fees per Semester Course

Fee	*General Chemistry*		*Qualitative Analysis*		*Quantitative Analysis*		*Organic Chemistry*		*Physical Chemistry*	
	Cases	*Per Cent*	*Cases*	*Per Cent*	*Cases*	*Per Cent*	*Cases*	*Per Cent*	*Cases*	*Per Cent*
$1.00.....					1	0.5				
1.25.....	1	0.4	1	0.4			1	0.4		
1.50.....			1	0.4						
2.00.....	3	1.2	2	0.9	2	0.9	1	0.4	3	2.6
2.50.....	3	1.2	1	0.4						
3.00.....	7	2.8	8	3.3	10	4.6	7	3.0	4	3.5
3.50.....	4	1.6	2	0.9	1	0.5	2	0.8	2	1.7
3.75.....	1	0.4	1	0.4	1	0.5	1	0.4	1	0.9
4.00.....	12	4.9	6	2.5	7	3.2	7	3.0	4	3.5
4.50.....	1	0.4	2	0.9	3	1.4	1	0.4		
5.00.....	50	20.3	45	18.6	34	15.7	33	14.1	21	18.3
6.00.....	20	8.1	17	7.1	14	6.4	19	8.1	5	4.3
6.50.....	1	0.4	1	0.4			1	0.4	1	0.9
7.00.....	10	4.1	11	4.6	7	3.2	11	4.7	3	2.6
7.50.....	27	11.0	39	16.2	28	12.9	33	14.1	13	11.3
8.00.....	9	3.7	7	2.9	14	6.4	10	4.3	6	5.2
8.50.....	1	0.4			1	0.5				
9.00.....	3	1.2	3	1.2			5	2.1		
10.00.....	42	17.1	39	16.2	32	14.7	37	15.7	16	13.9
10.50.....							1	0.4		
11.00.....					1	0.5				
12.00.....	4	1.6	2	0.9	1	0.5	6	2.4	3	2.6
12.50.....	2	0.8	4	1.7	6	2.8	7	3.0	2	1.7
13.00.....							1	0.4	1	0.9
14.00.....	1	0.4	1	0.4	2	0.9				
15.00.....	8	3.3	13	5.4	16	7.4	13	5.5	8	6.9
18.00.....	2	0.8	1	0.4	2	0.9	2	0.8		
20.00.....	2	0.8	1	0.4	1	0.5	2	0.8	1	0.9
22.00.....							1	0.4		
25.00.....			1	0.4						
30.00.....					1	0.5				
35.00.....							1	0.4		
No Fee.....	32	13.0	32	13.2	32	14.7	32	13.6	21	18.2
Cases.....	246		241		217		235		115	
Mode.....	$5.00		$5.00		$5.00		$10.00		$5.00	
Median.....	$6.00		$7.00		$7.00		$7.50		$6.00	

analysis $7.00, and in organic chemistry $7.50. Because of incomplete data in the catalogs available, some of the institutions were not included in this table, but, of those represented 13.0 per cent charged no laboratory

TABLE III

Laboratory Fees per Credit in Course

Fee per Credit	General Chemistry		Qualitative Analysis		Quantitative Analysis		Organic Chemistry		Physical Chemistry	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
$0.32.....	1	0.5							1	1.0
0.40.....							2	1.0	1	1.0
0.50.....	3	1.4	1	0.5	1	0.5	1	0.5	1	1.0
0.60.....	5	2.4	1	0.5	1	0.5	1	0.5		
0.63.....	2	1.0			2	1.0	1	0.5		
0.67.....	1	0.5	2	1.0	2	1.0	1	0.5	1	1.0
0.75.....	1	0.5	2	1.0						
0.80.....	1	0.5					1	0.5		
0.87.....	8	3.8								
0.90.....	1	0.5			1	0.5				
1.00.....	17	8.0	8	3.9	7	3.5	6	2.9	3	3.0
1.12.....			2	1.0	1	0.5			1	1.0
1.20.....	5	2.4	2	1.0	2	1.0	5	2.4		
1.25.....	21	9.4	18	8.8	17	8.5	18	8.7	10	10.0
1.30.....			3	1.5	2	1.0	2	1.0	3	3.0
1.33.....	5	2.4	3	1.5	3	1.5	4	1.9	3	3.0
1.40.....			1	0.5	2	1.0	2	1.0		
1.45.....					1	0.5	1	0.5		
1.50.....	21	9.9	20	9.8	19	9.5	18	8.7	5	5.0
1.60.....	1	0.5			1	0.5	1	0.5		
1.67.....	8	3.8	10	4.9	8	4.0	7	3.4	6	6.0
1.75.....	9	4.4	6	2.9	10	5.0	5	2.4	1	1.0
1.87.....	10	4.7	10	4.9	9	4.5	15	7.2	5	5.0
2.00.....	15	7.1	8	3.9	13	6.5	14	6.8	11	11.0
2.10.....			1	0.5	1	0.5	2	1.0		
2.25.....			2	1.0	3	1.5	2	1.0		
2.33.....			3	1.5			1	0.5		
2.40.....							2	1.0		
2.45.....					1	0.5	1	0.5		
2.50.....	25	11.8	31	15.1	25	12.4	28	13.5	12	12.0
2.67.....	1	0.5	2	1.0					1	1.0
2.80.....	2	1.0								
3.00.....	4	1.9	7	3.4	7	3.5	5	2.4	2	2.0
3.12.....	1	0.5			1	0.5	3	1.4	1	1.0
3.33.....	5	2.4	7	3.4	10	5.0	9	4.3	2	2.0
3.50.....	1	0.5	1	0.5	2	1.0	2	1.0		
3.75.....	2	1.0	5	2.4	6	3.0	5	2.4	4	4.0
4.00.....	1	0.5					1	0.5		
4.16.....			2	1.0						
4.33.....					1	0.5	1	0.5	1	1.0
4.50.....	2	1.0	2	1.0	2	1.0	3	1.4		
5.00.....			8	3.9	5	2.5	4	1.9	5	5.0
6.00.....			1	0.5						
7.00.....			1	0.5						
8.33.....			1	0.5						
10.00.....			2	1.0	2	1.0				

TABLE III—*Concluded*

Fees per Semester	General Chemistry		Qualitative Analysis		Quantitative Analysis		Organic Chemistry		Physical Chemistry	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
10.50.....					1	0.5				
11.67.....							1	0.5		
No Fee.....	32	15.2	32	15.6	32	15.9	32	15.5	20	20.0
Cases.....	212		205		201		207		100	
Mode.....	No Fee		No Fee		No Fee		No Fee		No Fee	
Median.....	1.50		1.67		1.67		1.75		1.67	

fee in general chemistry, 13.2 per cent no fee in qualitative analysis, 14.7 per cent no fee in quantitative analysis, 13.6 per cent no fee in organic chemistry and 18.2 per cent charged no laboratory fee in physical chemistry. The range of fees shown in the table is from nothing for a number of cases in all the courses to a fee of $35.00 for one course in organic chemistry.

Table III gives, where the additional information was available, the chemistry laboratory fees per credit in the courses. For all of the courses here studied no fee is charged more frequently than any one fee per credit. The median fee per credit for general chemistry is $1.50; for qualitative and quantitative analysis and physical chemistry, $1.67; and for organic chemistry the median fee per credit is $1.75. The fees range from nothing to $11.67 per credit.

Table IV shows the practice of 184 institutions with respect to change of fees with advanced courses. Fifty, or 27.2 per cent show a distinct increase of fees for advanced courses; only five, or 2.7 per cent show a decrease; 107, or 58.1 per cent show no change and 22, or 12.0 per cent are irregular with respect to change of fees for advanced courses. As it would generally be conceded that the advanced courses are more expensive, a uniform fee for all courses is equivalent to placing a large proportion of the expense actually incurred upon the elementary students. This practice is justified by some on the basis of the general requirement of the elementary course for many students.

TABLE IV

Change of Fees with Advanced Courses

Change	*Cases*	*Per Cent*
Increase	50	27.2
Decrease	5	2.7
No Change	107	58.1
Irregular	22	12.0
Total	184	100.0

Table V gives for 114 institutions the chemistry breakage deposits charged. No attempt was made to include in the table the institutions that required no breakage deposit or merely charged for "materials used."

It did not seem possible, from a study of the catalogs, to list the institutions having a definite policy of requiring a renewal of the deposit when "materials used" exceeded the amount of the original deposit.

TABLE V

Chemistry Breakage Deposits

Deposit	*Number of Cases*	*Per Cent*
$1.00	1	0.9
1.50	1	0.9
2.00	5	4.4
2.50	7	6.1
3.00	11	9.6
3.75	1	0.9
4.00	2	1.8
5.00	59	51.7
6.00	4	3.5
7.50	1	0.9
10.00	14	12.3
14.00	1	0.9
15.00	5	5.4
20.00	1	0.9
25.00	1	0.9

Cases—114
Mode—$5.00
Median—$5.00

Summary

The practice of the greatest number of institutions agreeing on any one procedure with respect to the charge of laboratory fees and deposits is to have a uniform fee for the fundamental courses, general chemistry, qualitative and quantitative analysis, organic, and physical chemistry. The most popular fee for this purpose is $5.00 per semester. The most generally required breakage deposit is $5.00. The median fee for general and physical chemistry is $6.00 per semester; for qualitative and quantitative analysis, $7.00; and for organic chemistry the median fee is $7.50 per semester.

If the chemistry laboratory fees are divided by the total credit per course, the number of institutions charging no fee exceed those charging any one fee per credit for all the courses. The most frequently charged fee per credit is $2.50 in all cases. The median fee per course credit is $1.50 for general chemistry; $1.67 for qualitative and quantitative analysis and physical chemistry; and $1.75 for organic chemistry.

If the chemistry laboratory fees are divided by the credit earned in laboratory, the number of institutions charging no fee out-number the institutions charging any one fee in the general chemistry, quantitative analysis, organic, and physical chemistry. The most frequently charged

fee in qualitative analysis is $2.50 per laboratory credit. The median fee per laboratory credit is $3.34 for general chemistry; $2.50 for qualitative and quantitative analysis; $3.75 for organic chemistry, and $4.00 for physical chemistry.

TABLE VI

Summary of Chemistry Laboratory Fees

		General Chemistry	*Qualitative Analysis*	*Quantitative Analysis*	*Organic Chemistry*	*Physical Chemistry*
Fee per	Highest Fee	$20.00	$25.00	$30.00	$35.00	$20.00
Semester	Mode	5.00	5.00	5.00	10.00	5.00
Course	Median	6.00	7.00	7.00	7.50	6.00
Fee per	Highest Fee	4.50	10.00	10.50	11.67	5.00
Credit in	Mode	No fee	No fee	No fee	No fee	No fee
Course	Median	1.50	1.67	1.67	1.75	1.67
Fee per Lab-	Highest Fee	18.00	18.00	15.00	18.00	15.00
oratory	Mode	No fee	2.50	No fee	No fee	No fee
Credit	Median	3.34	2.50	2.50	3.75	4.00

Table VI summarizes the practice with respect to chemistry laboratory fees. The range in each case is from no fee to the highest fee as listed.

The writers find no general and uniform philosophy of assigning chemistry fees and deposits. Any recommendation appealing to us has been implied by Thurber (*3*) in the statements:

> There are a number of institutions that have made the commendable change of charging just one fee which they call a tuition or incidental or contingent fee, and include all their charges under this head...
>
> ...The library fee is one that might properly come within the general fee...and if we go so far, why should not charges for the laboratories be averaged over a period of years and a flat fee included in the tuition or fee charged in the different schools?...It appears perfectly reasonable that all students within a particular school or college should be charged a flat fee for the laboratory, and the laboratories will be there for them to use just as the library is.
>
> ...The plan of stating a large number of different fees is to be deprecated...

Literature Cited

(*1*) WILLIAMS, "Student Fees in Home Economics," *J. Home Economics*, **16**, 650–2 (Nov., 1924).

(*2*) REEVES and RUSSELL, "College Organization and Administration," Board of Education, Disciples of Christ, Indianapolis, **1929**, pp. 230–1.

(*3*) THURBER, "Fiscal Support of State Universities and State Colleges," *Bureau of Education Bulletin* No. 28, **1924**, pp. 36, 37.

Early Roman Glass Annealing Oven Found. Among the Roman remains found during excavation on the important site at Caistor St. Edmund's, near Norwich, was an annealing oven for the manufacture of glassware, dating from the latter part of the Roman occupation of Britain. As evidence of the local manufacture of glass, it is a notable addition to the knowledge of Romano-British industries.—*Chem. Age*

AN ATOMIC MODEL CONTEST FOR HIGH-SCHOOL STUDENTS

WALTER B. DYE, WHITE'S PREPARATORY SCHOOL, BERKELEY, CALIFORNIA

A method is presented of increasing the interest of high-school chemistry students in the study of atomic structure and the periodic system. The essential features of this method are: (1) the organization of a contest; (2) the building of a static atomic model; (3) the preparation and presentation of a paper in class describing the properties of the atom designed. The ideas for designing and building these atomic models came from the study of the subject matter in the newer works of high-school chemistry.

• • • • • •

It can safely be said that a fundamental knowledge of the periodic system and atomic structure is of the greatest aid to the young student of chemistry, be he of collegiate or high-school age. But how are we to impress the high-school student, for example, with this fact? Unless the teacher finds some stimulating method of presenting this knowledge and the principles involved therein, the study of the periodic system and atomic structure may become merely dull routine memory work.

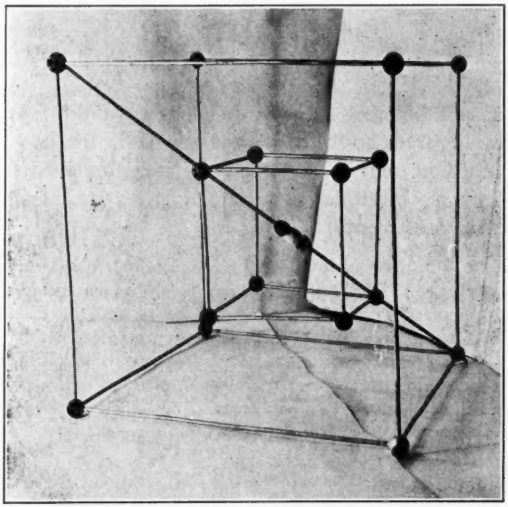

FIGURE 1.—Cl ATOM

The seven outer electrons represented by seven outer beads at corners painted red, eighth corner lower right foreground is painted with aluminum paint.

The writer of this article was faced with this problem in the teaching of high-school students. After trying various methods, the suggestion for an atomic model contest was found in one of the newer works in high-school chemistry. The methods suggested for making atomic models were modified to meet our particular needs.

Organizing the Contest

The class consisted of twelve students. They were divided into six teams. Each team was to construct an atom or a molecule, and at the same time prepare a paper or talk on the element represented by his particular

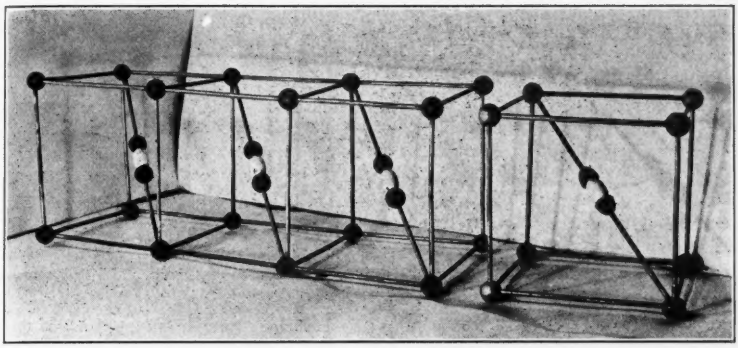

FIGURE 2.—LEFT, CO_2 MOLECULE; RIGHT, N ATOM

model. The students thoroughly understood that the models were static and not designed to represent a dynamic atom. Prizes were offered to the winning team. In our case paper weights, a "Campanile" and "Golden Bear," were appropriate because of proximity to the University of California.

Instructions

Each team was supplied with sufficient annealed steel wire No. 8 B. & S. gage approximately one-eighth inch in diameter to make the sides of a single shell atom, the dimensions of which were a five-inch cube. For an atom such as chlorine (Figure 1), the outside shell was a one-foot cube. Figure 2 represents a carbon dioxide molecule and a nitrogen atom. The corners were held by round wooden beads five-eighths inch in diameter. The laboratory vise held the beads, and the students used a one-eighth-inch bit for drilling the holes. The beads were purchased from a toy shop and were of the type used for "Tinker Toys." An oval-shaped bead was used for the nucleus and the two electrons on either side of the nucleus were made by sawing an oval-shaped bead crosswise through the center. After the wire sides were made, and the holes drilled in the wooden beads, the model was set up by gluing the ends of the wires in the beads. The model was then painted. The helium nucleus was painted white and the number of excess protons was marked with ink. All electrons were painted red, and the rest of the model was painted aluminum. We found that less than two hours' uninterrupted work by a team was necessary to construct a model, such as the lithium or beryllium atom. For such an atom, the cost of the wooden beads and the wire was approximately twenty-five cents.

Judging the Contest

Judges were selected from the university. One member of each team gave a brief talk of from five to seven minutes on his model and on the physi-

cal and chemical properties of the element which it represented. Various references were used in the preparation of these talks. As an introduction a student gave a brief history of the periodic classification pointing out the periodic changes of the properties of the elements by means of a chart. An outline for a talk on the chlorine atom is given below:

Name—Chlorine
Symbol—Cl
Melting point— −101.6°C.
Boiling point— −34.6°C.
Color of gas—greenish yellow
Atomic volume of solid cc.—23.52
Atomic weight—35.46
Isotopes—35, 37
Atomic number—17
Electrons in various quantum levels:
1st—2
2nd—8
3rd—7
Heat of vaporization cal. per mole—5000
Heat of fusion cal. per mole—1634
Solubility in water moles Cl_2 per liter—0.090 (1 atm.)
Analytical
Detection
Estimation
Gravimetrically
Volumetrically
Interesting Reactions

Conclusion

In the judging of the contest two points were taken into consideration: first, the technic used in constructing the model; second, the knowledge of the subject matter shown by the student in his talk.

References

1. GORDON, "Introductory Chemistry," New World Book Co., New York, **1927**, pp. 363–5.
2. HILDEBRAND, "Principles of Chemistry," Revised edition, The Macmillan Company, New York City, **1926**, pp. 252–72.
3. LATIMER and HILDEBRAND, "A Reference Book of Inorganic Chemistry," The Macmillan Company, New York City, **1929**, p. 122.
4. LINCOLN, "Physical Chemistry," D. C. Heath & Co., Boston, Mass., **1918**, pp. 64–81.

Garlic Smelling Metal, Tellurium, Useful in Disease Treatment. If the patient can stand the smell of tellurium, which has an intense garlic odor, it may prove useful in the treatment of syphilis in cases that do not respond to more usual medication.

Dr. A. D. Frazer, a health officer of the County Borough of Dudley, treated with tellurium or its salts, seven individuals who contracted the disease, most of them more than twenty years ago. Four cases out of the seven were favorably influenced by this new drug, though the standard cures were ineffective. Tellurium has the advantage over many other drugs in that it produces improvement when the disease is of long duration and firmly entrenched and the patient becomes resistant to treatment.

Since tellurium in the amounts given to patients is not poisonous, its only disadvantage seems to be the offensive smell. In countries where the aroma of garlic is tolerated or even liked, tellurium will, according to Dr. Frazer, prove of great value — *Science Service*

A BRIEF LESSON IN THE CHEMISTRY OF PIG IRON

G. T. Franklin, Lane Technical High School, Chicago, Illinois

It is doubtless the concern of many teachers of general chemistry how to attack the problem of iron and steel. To neglect the problem means a chance lost to review numerous chemical principles and an opportunity wasted to put into use knowledge previously studied. To organize the material suitable to the purpose has been the writer's difficulty. The school texts are of necessity limited in their discussions. Most of the technical works are too difficult for the beginner and the popular ones tend to submerge the chemistry in details of construction, etc. The paper represents an effort to put into brief space the work of considerable reading, observation of factories, and several years of experience in attempting to teach the topic to boys in a technical high school.

. . . . . .

The blast furnace used in the manufacture of pig iron is not a total stranger to many people. The numerous chemical reactions involved in the process are not generally known and much less understood. A comprehensive grasp of the essentials of the subject may be had by keeping in mind clearly the materials involved and the final products obtained. Numerous applications of a few principles of elementary chemistry are essential. It is common knowledge that pig iron contains such elements as iron, carbon, silicon, sulfur, phosphorus, and manganese. From the outlines in Figure 1 it is noted that the iron comes from the iron ore and unavoidably from the same source come silicon, phosphorus, and manganese. The sulfur comes from the coke. One might guess that some of the sulfur might come from the ore and some of the phosphorus from the limestone. Diligent search of the literature failed to find any authority for such statements.

No free elementary solid substances are introduced into the blast furnace except the carbon of the coke. The fact that elements exist in the furnace indicates a reducing action. The chief reducing agent is carbon monoxide. In Figure 1 is shown a series of chemical reactions, beginning near the top of the stock line and terminating in the zone of fusion. The list includes some of the most important; it is by no means complete. Some reactions oppose others. Of course it is important to provide the conditions to carry forward to an end reactions for the production of free iron and repress those which tend toward the reoxidation of the iron when formed. At some particular temperature and concentration, these reactions are all equilibrium reactions. As these factors change some of the reactions are repressed and others carried to an end. The reactions may be compared with those involving the preparation of a volatile acid. At room temperatures the reaction rapidly comes to equilibrium. The addition of heat carries forward the reactions to an end.

The purpose of the limestone is to furnish material which forms a fusible

mixture of substances insoluble in molten pig iron. Calcium carbonate decomposes to form infusible calcium oxide. The calcium oxide reacts with acid oxides to form fusible salts which act as solvents of other substances. Thus the slag includes the silicates, phosphates, and most of the sulfides. The metals that are set free are found in the pig iron. This does not necessarily mean that these elements are in the free form in the

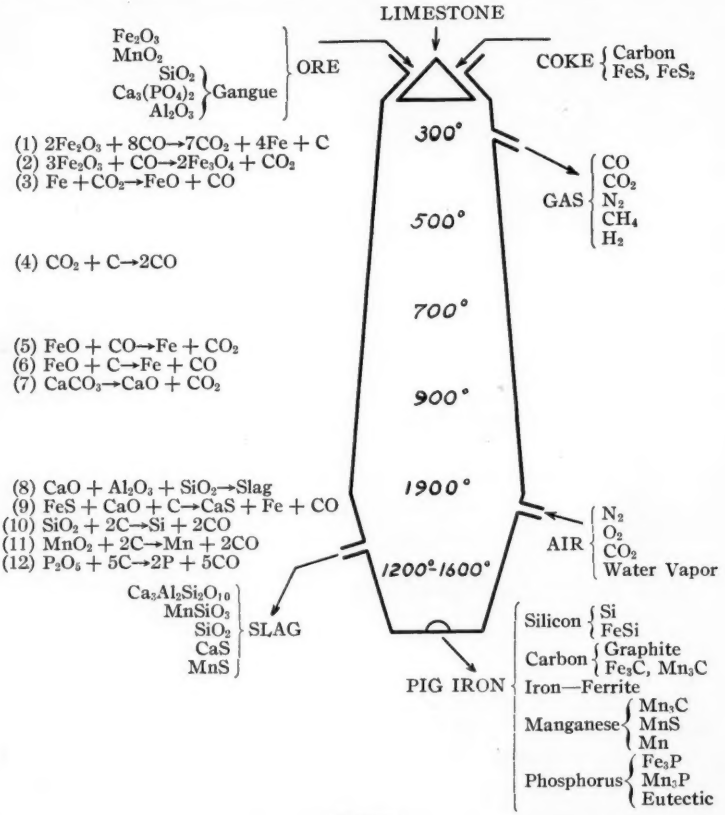

FIGURE 1

pig iron. The presence in the pig iron of phosphides and silicides means that phosphorus and silicon were set free in the furnace and then recombined. The outline in Figure 1 gives substances that may be found in pig iron. They may not all be present in any one sample.

Sulfur exists in soft coal as FeS_2. In coking about half of the sulfur is lost. In the upper part of the furnace the sulfur is all converted into

FeS (Figure 2). The FeS would pass into the pig iron if it were not for two powerful reducing actions, that of carbon shown in equation 9, Figure 1, and manganese shown in Figure 2. Manganese sulfide distributes itself between slag and pig iron, the larger percentage in the slag. The route of the manganese is shown in Figure 3. Aluminum and calcium are unreduced and pass out with the slag. Some of the phosphorus is reduced in the zone of fusion (equation 12, Figure 1) and is dissolved by the pig iron as phosphide of manganese or iron or as eutectic. A basic furnace tends to decrease the sulfur in pig iron but increases the phosphorus and manganese. Why? An acid furnace increases the sulfur in pig iron and causes much of the manganese to dissolve in the slag as manganese silicate. Why? High temperatures tend to decrease the sulfur in pig iron but increase the silicon and phosphorus. Why?

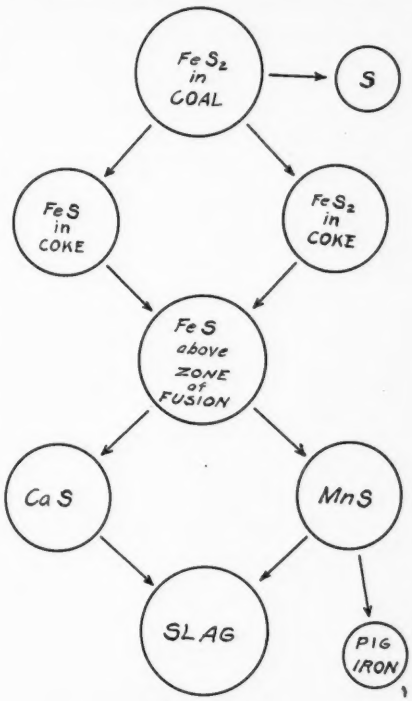

FIGURE 3

Many important details, not discussed so far, are suggested in the questions to follow. To answer the questions standard works should be consulted. A thorough review of many chemistry principles will doubtless be necessary in many cases. Outlines and diagrams included in Figures 1, 2, and 3 are intended to help. Many statements are made in technical works as facts to be remembered that are easily deduced from well-known chemical principles.

Questions

What solid materials are used in the blast furnace? What gaseous substance is introduced into the blast furnace? What liquid substances are taken from the furnace? What gaseous substance is obtained from the furnace?

List the metals that enter the blast furnace in the combined form in the order of their activity. Which of the metals would be most likely to be

reduced? If phosphorus and silicon were set free where would they be found, in the slag or the pig iron? Review methods for the commercial preparation of silicon and phosphorus and compare the conditions with those existing in the blast furnace. Do the conditions in the furnace warrant a guess that silicon and phosphorus would be reduced? Is it possible that a small portion of these elements might be reduced?

Review the chemistry involved in the manufacture of ordinary window glass. How do the conditions as to temperature and materials in the blast furnace compare with those of the furnace used in the manufacture of ordinary window glass? What is an acidic oxide? What is a basic oxide? What class of compounds is formed by reaction between a basic and an acidic oxide? Do sulfides of manganese and calcium dissolve in the slag or the pig iron? Would you expect free manganese to exist in the presence of iron compounds? Would you expect slag or pig iron to dissolve iron sulfide? Under what conditions would iron sulfide exist in pig iron?

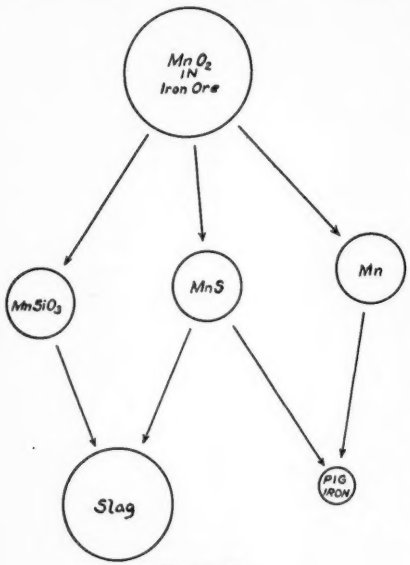

FIGURE 3

Are conditions favorable to the formation of free manganese in the blast furnace? If the element were set free, would it dissolve in the slag or the pig iron?

Review the methods used in the manufacture of producer and water gases and apply the principles to the reactions that take place when air is introduced into a blast furnace. Do the substances obtained from the furnace as gas corroborate your mental analysis?

Does a mixture of water and chloroform separate into layers because they are not of the same density, or because they are not miscible? Why do slag and pig iron in the molten condition separate into layers? Some potassium iodide solution is mixed with chloroform and shaken. What happens after a time? Now suppose a crystal of iodine is added to the mixture and shaken, where does the iodine go? Where would most of the iodine go, if chloroform and pure water were used? Suppose some salt crystals were shaken in a mixture of chloroform and pure water, where

would the salt go? Try to get a mental picture of the zone of fusion of the blast furnace, containing two immiscible solvents and a number of solutes. Apply the old saying "like dissolves like" and trace the route of each element through the furnace.

Review the methods used in the preparation of the carbides of calcium and silicon. Could other carbides be prepared in this way? Are conditions in the blast furnace favorable to the formation of metallic carbides? Suppose a sample of pig iron were dissolved in nitric acid and no carbon remained, how would you explain it? If carbon remained from the nitric acid solution, what allotropic form would be expected? How would you explain the odor of phosphine often obtained from this reaction? How would you explain the odor of hydrocarbons from the reaction?

Remembering that when a compound is decomposed energy equivalent to the heat of formation is absorbed, from a table of heats of formation determine which of the equations in Figure 1 are endothermic and which exothermic. (*Suggestion:* Write the equations in the following form and observe whether energy absorbed is greater or less than energy liberated—

$$\underset{(65{,}700\text{ c.} + 29{,}000\text{ c.})}{\underset{\text{(absorbed)}}{FeO + CO}} \longrightarrow \underset{97{,}000\text{ c.}}{\underset{\text{(liberated).}}{Fe + CO_2}}$$

It is readily seen from this equation that the energy absorbed is slightly less than energy liberated and consequently the reaction is exothermic.) Would it be desirable to use dry air in the furnace?

Why is it necessary for blast furnace gas to contain approximately 25% carbon monoxide?

Of three iron ores, hematite, limonite, and magnetite, which is most valuable for pig iron manufacture if each contained the same percentage of iron compound?

References

The following works were consulted and the facts used in this paper were taken from them:

1. AUSTIN, "Metallurgy of Common Metals," 6th edition, John Wiley & Sons, Inc., New York City, 1926.
2. BOYLSTON, "Iron and Steel," John Wiley & Sons, Inc., New York City, 1928.
3. BRAY, "The Principles of Metallurgy," Ginn & Co., Boston, Mass., 1926, chap. 15.
4. CAMPBELL, "The Manufacture and Properties of Iron and Steel," 4th edition, McGraw-Hill Book Co., Inc., New York City, 1907.
5. HAYWARD, "Outline of Metallurgical Practice," D. Van Nostrand Co., New York City, 1929, chap. 22.
6. HOWE, "The Metallurgy of Steel and Cast Iron," McGraw-Hill Book Co., New York City, 1916.
7. HUDSON and BENGOUGH, "Iron and Steel," D. Van Nostrand Co., New York City, 1916, chap. 2, p. 11.

8. PORTER, "A B C of Iron and Steel," 5th edition, Penton Publishing Co., Cleveland, Ohio, **1925,** chap. 7, p. 77.
9. ROGERS, "Manual of Industrial Chemistry," 4th edition, volume 1, D. Van Nostrand Co., New York City, **1926,** chap. 18.
10. SAUVEUR, "The Metallurgy and Heat Treatment of Iron and Steel," 3rd edition, McGraw-Hill Book Co., Inc., New York City, **1926,** chap. 22.
11. SPRING, "Non-Technical Chats on Iron and Steel," Frederick A. Stokes Co., New York City, **1917,** chap. 4, p. 52.
12. STOUGHTON, "The Metallurgy of Iron and Steel," 2nd edition, McGraw-Hill Book Co., Inc., New York City, **1911,** chap. 1.
13. STOUGHTON and BUTTS, "Engineering Metallurgy," McGraw-Hill Book Co., Inc., New York City, **1926.**
14. THORPE, "Industrial Chemistry," 3rd edition, The Macmillan Co., New York City, **1916,** p. 601.
15. "Encyclopaedia Britannica," 14th edition, Encyclopaedia Brittanica, Inc., New York City, volume 12, **1929.**
16. "New International Encyclopaedia," Dodd Mead and Co., New York City, volume 12, **1923.**

Aluminum Crane. Six unusual overhead traveling cranes have recently been built by the Northern Engineering Works, Detroit, Mich., for the U. S. Aluminum Co. for use in its new sheet rolling mills at Alcoa, Tenn. The unusual feature of these cranes is that each entire unit is made from aluminum alloy rolled structural sections and aluminum alloy castings. The crane illustrated has a capacity of 10 tons, the bridge space is 76 ft. 6 in. between truck wheels, and the hoisting hook has a height lift of 25 ft. The hoist operates at a full load speed of 50 ft. per minute, the bridge 400 ft. per minute, and the trolley 150 ft. per minute. The total net weight of the crane is 30,000 pounds, compared to 77,100 pounds for the same size equipment if built of steel.—*News Ed., Ind. Eng. Chem.*, **8,** 16 (Oct. 10, 1930)

Unique Office of Nirosta Steel. An office, decorated and fitted throughout in the same metal that gleams from the tower of the lofty Chrysler Building, has been added to New York's list of novelties.

This office, located on the twenty-sixth floor of the New York Central Building, is creating something of a sensation among those interested in the possibilities of the new alloy. In a display room is an exhibit of products produced from Nirosta steel ranging from a coil of wire having a diameter of less than half that of a human hair, to a huge chemical tank capable of handling boiling acids without material deterioration.

The room itself is paneled with Nirosta sheets that have been ground to a satin finish around the borders with a raised polished center. The decorative design has been etched into the metal and the furniture and exhibits include examples of this alloy in cast, rolled, drawn, spun, welded, wire, etched, and riveted form.

The product today has found its way into leading industries. A large tonnage has been used in the oil industry. Some of the other industries using it which are represented in the exhibits are the automotive, chemical, paper, architectural, food, marine, and aviation.

There are 48 American steel manufacturers of prominence now licensed to produce this material. The office and display room is maintained for these licensees by the Krupp Nirosta Co., Inc.—*News Ed., Ind. Eng. Chem.*, **8,** 12 (Sept. 10, 1930)

CRYSTALLIZATION

H. R. Fisher, Sunbury High School, Sunbury, Ohio

Crystallization and the change of substances from liquids to solids can be illustrated in a most interesting and rather spectacular way by the use of an ordinary projection lantern and a microscope slide projector. It is possible to actually see the various crystal formations slowly take shape. It is really a "motion" picture but there is no film—only a plain microscope slide, but it has never failed to arouse the keenest interest.

The equipment used for the demonstration was a Bausch and Lomb projection lantern and a slide projector made by the same company. A microscope slide was heated until it was almost uncomfortable to hold

Two Photomicrographs of Acetamide Crystals

and then on it was poured a small quantity of melted acetamide which was spread over the slide in a very thin layer. This was inserted in the slide holder of the projector. As the slide cooled the freezing point of the acetamide was reached and crystals formed on the slide.

The interesting part of the whole demonstration is when there suddenly appears on the clear screen a spear-like shaft moving from one side only to be met by another and another from all directions until the screen has more the appearance of a picture of a dense forest of palms or a window covered with gigantic frost crystals.

Crystals of a different type can be shown by using a supersaturated solution of salicylic acid and allowing it to cool to its crystallization point on the slide.

Will the College Athlete Succeed in Business? Achievement on the baseball diamond of college as well as success in the classroom is an important index of how a man will succeed in business, Donald S. Bridgeman, of the American Telephone and Telegraph Company, has reported to the Personnel Research Federation.—*Science Service*

A MODIFICATION OF THE STANDARD HIGH-SCHOOL EXPERIMENT ON THE DESTRUCTIVE DISTILLATION OF SOFT COAL

GUSTAV L. FLETCHER AND IRVING FINE, JAMES MONROE HIGH SCHOOL, NEW YORK CITY

A method is suggested whereby the presence of ammonia in coal gas may be successfully detected. Lime is introduced into the coal-tar collector.

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In order to detect ammonia as one of the by-products formed during the destructive distillation of soft coal, most laboratory manuals direct the student to place a piece of wet litmus paper over the mouth of the jet tube. The authors have found that this procedure invariably results in failure in that the litmus paper always turns red instead of blue.

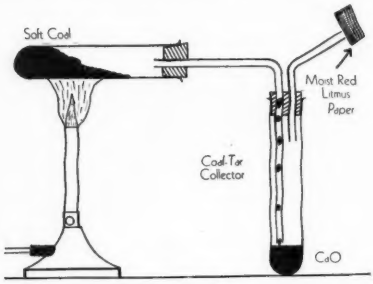

FIGURE 1

At the James Monroe High School, the following method, which will be recognized as a variation of the customary commercial practice, has been used with high success.

The student is first directed to heat the bituminous coal in the standard apparatus (Figure 1) and to note the fact that tar and a combustible gas are formed. He is then told to put about ten grams of quicklime (or slaked lime) into the coal-tar collector and to continue heating. At this point, a piece of wet litmus paper is held in the path of the gas issuing from the jet tube and the student finds that the red litmus paper turns blue, indicating the presence of ammonia. The student will also find that the combustible property of the coal gas has not been materially reduced by the absorption of the acids by the lime.

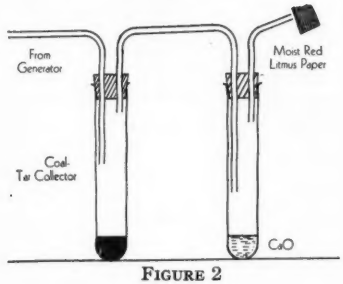

FIGURE 2

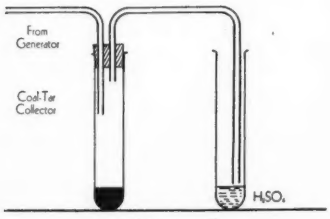

FIGURE 3

The aforementioned procedure may be varied by using one of the following plans: (*a*) instead of merely using one test tube to collect the coal tar, two test tubes may be connected in series (Figure 2); the first test tube will collect the coal tar and the

second, containing lime, will collect the acidic vapors of carbon dioxide and hydrogen sulfide. (*b*) Instead of lime, sulfuric acid may be used in the second test tube (*Figure 3*). The acid, of course, will combine with the ammonia, which later can be driven off by heating with lime.

The presence of ammonia in coal gas can thus be very satisfactorily demonstrated.

Shelled Nuts Often Form Soap Deposits in Glass Containers. The mystery of the frostlike deposit frequently seen on the inside of glass jars containing shelled pecans, or other nuts, has been solved by E. K. Nelson and H. H. Mottern, Bureau of Chemistry and Soils. The deposit is soap, these chemists say, and it is formed by the action of the acid fat of the nuts on the alkali of the glass. It causes a financial loss in the sale of the product.

The unexplained presence of the soapy deposit has long been a source of annoyance to packers of shelled nuts and to some housewives in the South who put up shelled pecans in glass jars when the nuts are plentiful and inexpensive. Although the soap does not impair the quality of the nuts, it presents an unsightly appearance and reacts against the sale of the product.

When the problem was presented to the chemists for solution, their first thought was that the jars might have been washed with an alkaline cleaner and that some of the alkali remaining on the glass had come in contact with the acid fat of the nuts and produced the chemical change common in soap manufacture. Study proved this theory incorrect, however.

Further investigation showed that shelled nuts packed in ordinary glass containers formed the white deposit, whereas nuts put up in hard-glass containers at the same time and under the same conditions formed no deposit. It was concluded, therefore, that the soap was formed by the action of the nut fat on the glass.—*The Official Record*

Some Bacteria Breathe Hydrogen, Not Oxygen. Bacteria that find oxygen, the very breath of life to most organisms, to be a rank poison and that breathe hydrogen instead, have had their physiological secrets investigated by Prof. J. W. McLeod of the University of Leeds school of medicine. Prof. McLeod presented his findings at the Fifth International Botanical Congress, recently held at Cambridge, England.

Plants and animals take up oxygen simply as the readiest means of obtaining energy from food substances. These bacteria, which prefer places where there is little or no air, are able to get their needed energy by a different process. They detach hydrogen from certain complex organic compounds, and the breaking apart of these molecules releases energy.

Oxygen is inimical to this process. If the newly released hydrogen comes into contact with oxygen the two elements unite to form hydrogen peroxide. Bacteria that can live in the presence of a very little air can tolerate a certain low concentration of hydrogen peroxide, but those that demand surroundings where there is no oxygen at all apparently find themselves paralyzed if hydrogen peroxide is generated even in small quantities.

A curious fact about these oxygen-hating bacteria is that they are quite lacking in one of the enzymes or organic ferments, catalase. This particular enzyme was once thought to be absolutely indispensable to any kind of life.—*Science Service*

MORE EFFECTIVE INDIVIDUAL LABORATORY INSTRUCTION IN GENERAL INORGANIC CHEMISTRY. II. AN EXPERIMENT ON MOLECULAR WEIGHTS*

W. E. BRADT, THE STATE COLLEGE OF WASHINGTON, PULLMAN, WASHINGTON

An experiment on molecular weights, designed for use in a system of instruction recently developed at the University of Cincinnati, is described. This permits unusually efficient individual instruction of students with varying previous chemical experience.

Outstanding phases of the method, which are illustrated by this experiment, include the application of required reference work in the laboratory, emphasis on the relationship between experimental and theoretical chemistry, the development of an interest in chemistry by means of semi-popular references, and increased instructional time for the laboratory assistants, with full instructional time for the instructor. The experiment is definitely of a college caliber and is designed to develop in the student correct habits of study and originality of thought.

. . . . . .

The author has developed a method** for teaching general inorganic chemistry laboratory which permits more effective individual laboratory instruction, and which remedies some of the weaknesses frequently found in beginning chemistry laboratory courses. The general phases of this method have been previously described (*1*). The purpose of this paper is to present, by means of specific illustrations taken from a typical experiment, this method for securing more efficient laboratory instruction.

A series of experiments has been chosen with an inclination toward more difficult and more quantitative requirements than are frequently found in general chemistry laboratory courses. Wherever possible, accurate methods are employed, the originality of the student is encouraged, and the task is designed to challenge the ability of the student. Very frequently the use of a *known* in a given procedure is followed by the use of an *unknown*, thus evaluating the laboratory technic of the student. All notes are written in the laboratory when the data are first obtained.

An experiment on molecular weights, designed to fulfil these requirements, is briefly considered below:

Object

A consideration of available methods and the development of a suitable apparatus and procedure for the determination of molecular weight.

It should be noted that the object is not the obtaining of a value identical with the correct value, but that it is a study of methods and the im-

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** This paper is based upon methods developed and used in The Department of Chemistry of the Liberal Arts College of the University of Cincinnati.

provement of these methods by the student. In no part of the experiment does the student receive the impression that his results will be even approximately correct. When a *known* substance is being investigated the student is cautioned that he is being judged mainly on his laboratory technic and on the originality and efficiency of his procedure.

Topics Covered

Molecular weights by vapor-density method. Avogadro's hypothesis. Absorption of vapor. Weighing of vapor. Gram-molecular volume. Distinction between atoms and molecules. Molecular weight and vapor pressure. Molecular weight of dissolved substances. Molecular weight by steam distillation.

The purpose of these quite general topics is to enable the student to study in the "Required References" (*2*) the main points of the experiment. The student is urged to acquaint himself with the general nature of each of the above topics before proceeding with the experimental work. All students (both with and without previous chemical experience) are expected to have mastered these topics during this experiment.

Required References

The "Required References" is merely a list of books (*2*) which were easily available at the time they were needed and does not pretend to be an ideal list of references. Students who have had no previous chemistry are expected to study references 1, 2, and 3. Students with previous chemical experience are expected to acquaint themselves with the material of the body of the experiment and of the "Study Topics" (see page 156) by means of these references. They will normally study all or parts of 1–3, 5–8, and 9.

Since several of the references are advanced texts, the student is very readily relieved of the impression that he is repeating a high-school course. All quiz questions are based on topics occurring in the body of the experiment and in the first three references. Consequently the use of the more advanced references by students makes possible as thorough a study of these topics as the student's previous chemical experience and ability permits. On the other hand, students with no previous chemical experience may receive a maximum mark by a careful study of the first three references and of the experimental work. This situation counteracts very well the difficulties common to classes composed of students with varying previous chemical experience.

These reference books were kept on a table in the laboratory. In a section of seventy students, a continually changing group of from five to ten students would be found at the table at any one time. A student seldom spent more than ten minutes there at one time but he would usually

return two or three times in a three-hour laboratory period. It is the author's opinion that the use of these references, coupled with the use of more difficult tasks, is the most valuable part of this method. It has more than fulfilled expectations.

Optional References

As has been previously explained (*1*), the "Optional References" (*3*) have no direct connection with the experiment. They are intended to present to the student the more interesting phases of chemistry. The student may choose two references which are to him the most interesting and there is no examination over the subject matter of these books. Most students do not study, but read and enjoy two complete books during the year. The author has observed that students who consistently read the "Optional References" frequently answer examination questions with material from these sources. Further, although no grades are based on "Optional References," these students are usually the ones who receive the maximum mark for the course. After completion of the year's work many students have voluntarily made favorable comments regarding this requirement.

Apparatus and Materials

These include suggested lists of supplies which the students will use during the experiment.

Experimental Details

1. Molecular Weight by Vapor-Density Method.—Students who work in pairs on the determination of molecular weights by the vapor-density method are first referred to "Required References" (*2*) 1, 2, and 3, and to special paragraphs in 5, 6, and 7. An elementary explanation of the theory is given in the body of the experiment, with some suggested methods for absorbing various vapors. The assigned task is two-fold: first, to develop and use an apparatus and procedure for the determination of vapor density and molecular weight of the assigned vapor; and, second, after a consideration of the results obtained by this method, to devise and install improvements, redetermine the vapor density and recalculate the molecular weight. All results are reported to the Record Assistant (see "Instructions to Record Assistant" below) with suggestions for further improvements and theories explaining any erroneous results.

This task has been very successful in arousing interest and originality in the student. Variations of the methods devised by Evans, *et al.*, have given very satisfactory results with water. Other vapors such as hydrogen chloride, carbon dioxide, and sulfur dioxide may be adapted to the same general methods.

It is impressed upon the student that his apparatus and procedure are considered of more importance in the calculation of grades than are the values obtained for the molecular weight of the vapor being investigated. These results are usually sufficiently accurate to impress the student with the idea that if his method were more accurate the results would have been correct. Because of this situation many interesting variations are introduced on the second attempt. Students uniformly become very enthusiastic about this phase of the experiment. All notes are written in the laboratory and are turned in to the Record Assistant without recopying.

2. Molecular Weight by Freezing-Point Method.—Students are referred to special paragraphs in "Required References" (*2*) 1, 5, 6, 7, and 8, and are instructed to devise a suitable apparatus from available materials and to develop a suitable procedure for the determination of the molecular weight of a known substance by this method. If available, thermometers graduated to one-fifth of one degree are used, but the ordinary 150°C. thermometer, graduated in degrees, is sufficiently accurate, particularly if higher concentrations of substances with low molecular weight are used in solvents exhibiting large molal depression values, as does benzene. A very satisfactory apparatus can be assembled from this thermometer, a 1500-cc. beaker and a large and small test tube with suitable stirrers and stoppers. Results obtained using such an apparatus for the determination of the molecular weight of naphthalene in benzene have been quite satisfactory. After the student has established the accuracy of his method he is given an *unknown* solute and asked to determine and to report its molecular weight. Occasionally, students have become so interested that, without suggestion from the instructors, they have asked permission to investigate the dissociation of electrolytes in water by this method.

3. Molecular Weight by Steam-Distillation Method.—Students are referred to pertinent paragraphs in "Required References" (*2*) 1, 7, 8, and 9. An elementary discussion of the relation between vapor pressure and molecular weight is included in the body of the experiment with some suggestions regarding the apparatus. Substances such as nitrobenzene, aniline, and toluene have been used with fairly satisfactory results. Students usually institute variations in the method which improve the accuracy of the determination and are graded on the value of these innovations as well as on the experimental results.

4. Molecular Weight of an Unknown.—An *unknown* substance is issued to the student who determines its properties, chooses the most desirable method, then determines and reports molecular weight of the unknown to the record assistant. The student is graded upon the accuracy of the reported result.

Exercises

These consist of twenty incomplete equations and ten problems, most of which pertain to the topics being studied. These are performed outside of laboratory hours and, with occasional review assignments and the optional references, consist of the only outside requirement in connection with the laboratory course.

Study Topics

1. Gay-Lussac's law.
2. Avogadro's hypothesis.
3. Gram-molecular volume. Gram-molecular weight.
4. Molecular weight from vapor density.
5. Atomic weights.
6. Equivalent weights.
7. Dulong and Petit's law.
8. Atoms *vs.* molecules.
9. Work of Canizzaro.
10. Molecular formulas.
11. Interactions between gases.
12. Dissociation.
13. Association.
14. Solutions.
15. Raoult's law.
16. Vapor tensions of solutions.
17. Ideal solutions.
18. Elevation of boiling point in solutions.
19. Depression of freezing point in solutions.
20. Law of partition.
21. Immiscible solvents.
22. Absorbing agents.
23. Dehydrating agents.
24. Molar weights.
25. Cryoscopic method for molecular weights.
26. Abnormal molecular weights.
27. Steam distillation.
28. Horizontal condensers.
29. Molecular weights by steam distillation.

These "Study Topics" are purposely not in the form of questions. They are designed to present to the student a review outline for the whole experiment, which in this case represents from fifteen to eighteen laboratory hours. This is an elastic assignment because students with no previous chemistry will review only from the body of the experiment and the first three "Required References," while the student with previous chemical experience will study the same topics in the more advanced references. This phase of the method has proved very valuable in correlating the lecture and laboratory courses. Conscientious students use the "Study Topics" as a guide in their study. By this means proper emphasis can be placed on the important theoretical phases of a subject which are so often overlooked in a laboratory course.

Quiz

The quiz, which is given as a written examination, consists of from five to ten questions. It is based on the "Topics Covered," the "Study Topics," on the material found in the body of the experiment, and on the "Exercises." All questions are definitely answered in these sources and in the first three "Required References." Consequently, a capable and

conscientious student without previous chemical experience very frequently attains the maximum grade.

Instructions to Record Assistant

Materials Needed on Table.—Required references. Record forms. Slide rule. Materials for generation of unknown vapors and materials for unknowns in freezing-point method and steam-distillation method.

Records to Be Kept:

1. Grade (% × 3) on notes.
2. Grade (%) on problems.
3. Grade (%) on equations.
4. Grade (% × 5) on written quiz.
5. Record of vapor assigned for V. D. M.
6. Grade (% × 2) on apparatus and procedure for Vapor-Density Method (from Floor Assistant).
7. Reported molecular weight obtained from data recorded in notes on V. D. M.
8. Grade (%) on reported molecular weight from V. D. M.
9. Grade (%) on "time-temperature" curves in notes.
10. Record of *unknown* substance issued for use in Freezing-Point Method (F. P. M.).
11. Grade (%) on apparatus and procedure for F. P. M. (from Floor Assistant).
12. Reported molecular weight obtained from data recorded in notes on F. P. M.
13. Grade (%) on reported molecular weight from F. P. M.
14. Record of substance issued for use in Steam-Distillation Method (S. D. M.).
15. Reported molecular weight obtained from data recorded in notes on S. D. M.
16. Grade (%) on reported molecular weight from S. D. M.
17. Record of *unknown* substance issued for molecular-weight determination.
18. Reported molecular weight of *unknown* substance.
19. Grade (% × 2) on reported molecular weight of *unknown*.
20. Grade (%) on condition of desk at end of laboratory period (one day).

The author has found it advantageous to include in the manual written instructions to the Record Assistant. By means of this an assistant instructor's duties are clearly defined. He has a better opportunity to coöperate with the plans of the instructor and is not dependent on daily oral consultation with the instructor regarding routine or semi-routine matters. The student is graded on twelve points and these are so weighted that a total of 2000 per cent points are possible. The quiz is given a value approximately equal to one-fourth, and the notes a value of one-sixth, of the total possible grade. The notes are graded on organization, on the inclusion of *all* quantitative data (such as records of weights, temperature readings, etc.), theoretical discussions, and on neatness. Notes are initialed daily by the "Floor Assistants." By this means it can be established that the notes were written in the laboratory. Notes recopied outside of the laboratory hours are not accepted.

Merits of Procedure Outlined

It will be noted that in this experiment the emphasis has been placed upon the development of the student's originality. The tasks necessi-

tate considerable thought on the part of the student, the development of an apparatus in which he becomes quite interested, and leaves him with the impression that he has accomplished a difficult task. Since the references include such books as the texts by Chapin, Getman, and Findlay, the development of the theory connected with the determination of molecular weights is available to the student. The better students insist on understanding this material. Consequently, the "Floor Assistants" (whose chief duty is instruction) are usually occupied in explaining difficult points instead of devoting their time to obvious answers for thoughtless students. The student asking unnecessary questions is uniformly referred to the references for an answer.

Although this method of laboratory instruction still contains weaknesses, it permits efficient individual instruction of students with varying previous chemical experience in the same laboratory section. It eliminates the tendency to leave early or to loiter about the laboratory after the completion of a short daily task. It divides the course into the major divisions of the subject. It emphasizes the relationship between experimental and theoretical chemistry. It substitutes for the daily quiz a more efficient, more comprehensive, and a more carefully balanced written quiz. It presents to the student, by means of optional references the more entertaining phases of chemistry. It increases the instructional time of the assistants, and, what is more important, enables the instructor to devote his entire attention to the instruction of the individual student. It presents, to the class, tasks which are definitely of a college caliber, in a way designed to develop in the student correct habits of study and originality of thought.

Literature Cited

(*1*) BRADT and SMOKER, "More Effective Individual Laboratory Instruction in General Inorganic Chemistry," J. CHEM. EDUC., **6**, 1933–9 (Nov., 1929).

(*2*) The "Required References" are:

1. KENDALL, "Smith's Inorganic Chemistry," revised edition, The Century Co., New York City, **1926**, pp. 189–216.
2. EVANS, DAY, PEASE, and BLAND, "The Vapor Density of Steam," J. CHEM. EDUC., **1**, 152–3 (Sept., 1924).
3. MARTIN, DAY, and EVANS, "The Vapor Density of Steam," *ibid.*, **6**, 107–8 (Jan., 1929).
4. HOLMES, "Introductory College Chemistry," The Macmillan Co., New York City, **1925**, pp. 77–83.
5. CHAPIN, "Second-Year College Chemistry," second edition, John Wiley & Sons, Inc., New York City, **1926**, pp. 43–9.
6. FINDLAY, "Practical Physical Chemistry," fourth edition, Longmans, Green & Co., New York City, **1923**, pp. 112–23.
7. GETMAN, "Outlines of Theoretical Chemistry," fourth edition, John Wiley and Sons, Inc., New York City, **1927**, pp. 205–6.

8. DAVISON and VAN KLOOSTER, "Laboratory Manual of Physical Chemistry," John Wiley & Sons, Inc., New York City, **1922,** pp. 69–73.
9. Chemistry Handbook containing tables of vapor tensions of water.
10. MELLOR, "Modern Inorganic Chemistry," Longmans, Green & Co., New York City, **1920,** p. 218.
11. BLANCHARD, "Introductory General Chemistry," Doubleday, Doran & Sons, Inc., Garden City, N. Y., **1928,** pp. 91–2.
12. LINCOLN and BANKS, "General Chemistry," Prentice-Hall, Inc., New York City, **1928,** pp. 192–5.
13. DEMING, "General Chemistry," second edition, John Wiley & Sons, Inc., New York City, **1925,** pp. 176–80.

(*3*) The "Optional References" are:

14. ARRHENIUS, "Chemistry in Modern Life," D. Van Nostrand Co., New York City, **1925,** Chap. 13 and 14.
15. HOWE, "Chemistry in the World's Work," D. Van Nostrand Co., New York City, **1925,** Chap. 13 and 14.
16. SLOSSON, "Creative Chemistry," The Century Co., New York City, **1919,** Chap. 13 and 14.
17. "Chemistry in Industry," Vol. I, third edition, The Chemical Foundation, Inc., New York City, **1926,** Chap. 13 and 14.
18. "Chemistry in Industry," Vol. II, third edition, The Chemical Foundation, Inc., New York City, **1926,** Chap. 13 and 14.
19. FARRELL, "What Price Progress?" G. P. Putnam's Sons, New York City, **1926,** Chap. 13 and 14.
20. "Popular Research Narratives," Vol. II, Williams & Wilkins Co., Baltimore, Md., **1924,** pp. 137–71.
21. "Chemistry in Medicine," The Chemical Foundation, Inc., New York City, **1926,** Chap. VIII, Parts 1, 2, and 3.

Soil Type Has Effect on Storage Life of Apples. The amount of potash in the soil of the orchard appears to have an important bearing on the storage life of the apples produced. Dr. Franklin Kidd and Dr. C. West, of the Low Temperature Station, Cambridge, England, have found that the storage life of apples on which they worked increases as the amount of available potash in the soil increases. Trees grown in soils deficient in available potash yield apples which are particularly susceptible to low-temperature breakdown in cold storage. In order to insure a long storage life it therefore seems important that there should be a good supply of available potash in the soil.—*Science Service*

Canned Fruit in Cold Storage Keeps Natural Color Better. The natural fruit colors of certain canned fruits are preserved much better when the cans are kept in cold storage than when they are kept at ordinary temperatures. T. N. Morris and J. M. Bryan of the Low Temperature Station, Cambridge, England, have recently found that canned strawberries stored for three months at a temperature just above freezing have a fine red color, whereas those kept at 10 degrees below zero Fahrenheit are pale, and those stored at ordinary room temperature are also somewhat pale. The strawberries from cans stored at just above freezing actually had a much better appearance than when they were first canned because the color had returned to the fruit from the sirup.—*Science Service*

AN INEXPENSIVE BURET SUPPORT

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Various types of buret supports and devices for convenient filling can be found in the literature. We have used the design shown in Figure 1 for the past two years in several of our research laboratories and find it unusually satisfactory. This type of support includes the following desirable features. (1) The materials required are very inexpensive and are usually available in any laboratory. (2) No special mechanical skill is required for its construction. (3) It can be fitted equally well to any size of reagent bottle. (4) Reagent bottles thus equipped can be conveniently transported without dismantling, and the solution can be thoroughly agitated without danger of breaking the apparatus. (5) The buret is held rigidly at both ends and the scale is nowhere obstructed. (6) The flexible rubber buret connection totally eliminates breakage of the glass tubing due to misalignment or slight distortion. (7) The wood upright protects both the flask and the reagent bottle from accidental breakage due to striking the flask against the bottle when titrating into a flask. (8) The buret is easily and quickly filled by suction and, unlike the gravity-filled type, there is no danger of any reagent entering the buret during titration.

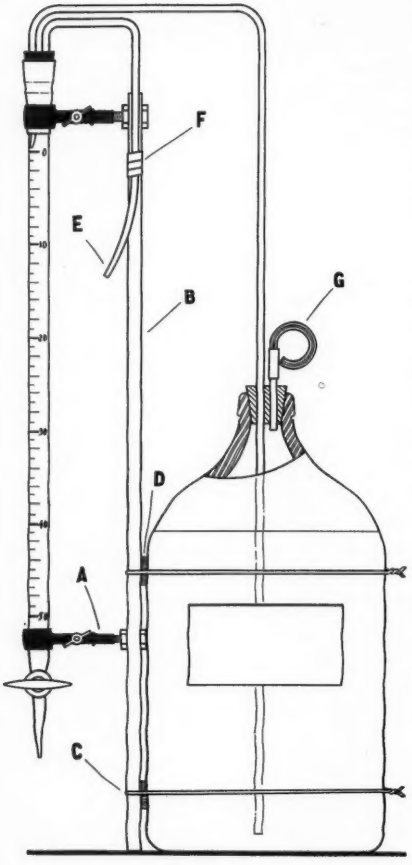

Figure 1

In Figure 1, *A* represents a regular single buret clamp with the rod clamp removed. *B* is a wood slat $^3/_4$ inch thick by 1 and $^1/_2$ inch wide and of suitable length. The wood slat is firmly attached to the bottle with wires *C*. Rubber cushions *D* prevent the slat from slipping sidewise. The buret is filled by attaching a rubber tube to the glass tube *E* and suck-

ing. Tube *E* is secured with adhesive tape at *F*. A capillary tube *G* prevents undue evaporation, and serves for the air inlet. Figure 2 shows the details of the flexible rubber buret coupling. This permits the use of a considerably larger two-hole stopper than could be properly inserted directly into the buret opening and provides splendid flexibility.

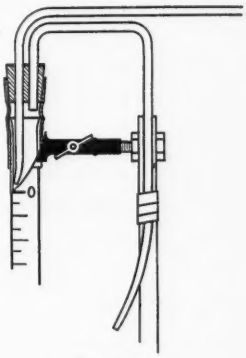

FIGURE 2

Figure 3 shows the type of buret coupling used for alkaline solutions, where the buret must be removed and cleaned promptly after use to prevent etching. *H* is a glass tube about 1 inch inside diameter (the neck of a broken distilling flask is ideal). *I* is a two-hole stopper which remains permanently fixed. A rubber stopper *J* is bored so it will fit the buret top very snugly. This stopper remains fixed on the buret. In order to remove the buret from the coupling it is merely necessary to loosen the lower clamp (Figure 1), and with a gentle twisting motion loosen the buret above. In order to prevent stopper *J* from sticking in tube *H*, the contact surface of the stopper is rubbed with graphite containing a little vaseline. Since the solution does not come into contact with the stopper, there is no danger of contamination. This type of coupling does not possess the flexibility of that shown in Figure 2, but due to the fact that stopper *I* is rigidly fixed, the small glass tubes are not strained while removing or replacing the buret.

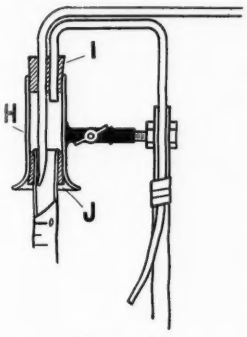

FIGURE 3

Acetaldehyde Tried Out in Fruit Preservation. Acetaldehyde vapor may prove of future use in the preservation of fruit because it kills the spores of molds without injuring the fruit itself.

This conclusion has been reached by two investigators who have worked on different sides of the question. R. G. Tompkins, of the Low Temperature Station, Cambridge, has shown that acetaldehyde vapor rapidly kills the spores of the molds and fungi which are likely to cause fruit spoilage.

In the same laboratory, S. A. Trout has recently found that healthy fruits can absorb a certain amount of acetaldehyde vapor without any harmful effects. The acetaldehyde is used up by the tissues of the fruit and soon disappears, leaving no trace of flavor. The possibility of applying this work to the fruit industry is under investigation.—*Science Service*

DÖBEREINER'S TRIADS AND ATOMIC NUMBERS

JACK P. MONTGOMERY, UNIVERSITY OF ALABAMA, UNIVERSITY, ALABAMA

Of the many attempts to base classifications of the elements upon unchanging constants of the atoms the first of any great value was that of Döbereiner in 1829. He called attention to the fact that it is possible to select elements in groups of three, the chemical behavior of the elements being similar, but also progressing relatively with increase of atomic weight in such a manner that the atomic weight of the central member is approximately the mean of the other two, while the properties of the second member are intermediate between the first and third. He called such groups of elements triads. Although this relation was fragmentary, it was the forerunner of our present periodic system and it is interesting to note that each set of the triads of Döbereiner is now found in its appropriate group of the periodic table.

Just as the discovery of atomic numbers made the periodic classification more useful and interesting, the working out of the idea of Döbereiner with atomic numbers, instead of atomic weights, enables us not only to get an exact, instead of an approximate, relationship but indicates the underlying cause.

The relation will be clearly seen by reference to the table in which are listed some of the triads, with both atomic weights and atomic numbers, it being observed that the relationship is approximate only with the atomic weights, but is exact with the atomic numbers.

Element	*Atomic Weight*	*Mean*	*Atomic Number*	*Mean*
Chlorine	35.457		17	
Bromine	79.916	81.19	35	35
Iodine	126.932		53	
Sulfur	32.064		16	
Selenium	79.2	79.78	34	34
Tellurium	127.5		52	
Calcium	40.07		20	
Strontium	87.63	88.72	38	38
Barium	157.37		56	
Phosphorus	31.027		15	
Arsenic	74.96	76.40	33	33
Antimony	121.77		51	

The arithmetic explanation of the exact relationship shown by the atomic numbers will be obvious to one who notes that, on a periodic chart containing the atomic numbers, a set of triads falling into the same group results in a progression of atomic number from member to member of the triad of 18 in each case. Starting with any number, adding 18 to get a second number, and adding another 18 to get a third number, the second number will be the mean of the other two.

Correspondence

SUPPLEMENTARY DIRECTIONS FOR PREPARING SOLUTIONS FOR DEMONSTRATION OF CHANGES IN IONIC EQUILIBRIA DURING CHEMICAL REACTIONS

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In the November, 1930, issue of the JOURNAL OF CHEMICAL EDUCATION appeared an article by Hosmer W. Stone* describing a demonstration experiment to illustrate ionic equilibria during chemical reactions. Those teachers of high-school chemistry who would like to perform that experiment, but find it a tedious and long performance to obtain the desired concentration of the solutions, following the directions given by Mr. Stone, will probably find the following table useful. The solutions indicated in this table do not give *perfect* results, but are satisfactory for classroom demonstration. They may be prepared with little difficulty and very quickly. I use an ordinary medicine dropper to measure the drops. Of course, I need not point out that for the best results it is imperative to use distilled water. Following the directions of this table my students in first-year chemistry have successfully prepared these solutions.

TABLE

Reaction No. I $Na^+OH^- + H^+Cl^- \longrightarrow Na^+Cl^- + H_2O$

Reaction No. II $Ba^{++}2OH^- + 2H^+SO_4^{--} \longrightarrow BaSO_4 + 2H_2O$

Reaction No. III $NH_4OH + HAC \longrightarrow NH_4^+AC^- + H_2O$

Reaction No.	*Solution Necessary*	*Ordinary Lab. Materials*	*Directions for Preparing Solutions*
I	NaOH	U. S. P. Sticks	*Solution A:* 1 gram to 100 cc. H_2O. Of solution A add 50 drops to 150 cc. H_2O
I	HCl	35.4–37.5% HCl	*Solution A:* 5 cc. acid to 50 cc. H_2O. Of solution A add 25 drops to 150 cc. H_2O
II	$Ba(OH)_2$	Pure crystals	*Solution A:* saturate solution at 20°C. and filter. Of solution A add 20 cc. to 140 cc. H_2O
II	H_2SO_4	94.2–95.6% H_2SO_4	9 drops to 150 cc. H_2O
III	NH_4OH	28–29% NH_3	6 drops to 150 cc. H_2O
III	HAc*	30% HAc	6 drops to 150 cc. H_2O

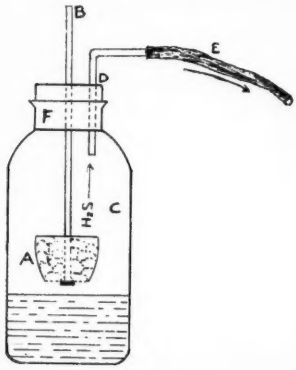
* CH_3COOH.

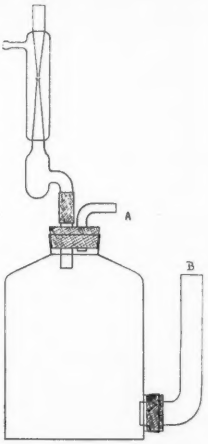
* STONE, J. CHEM. EDUC., **7**, 2722–4 (Nov., 1930).

Abstracts

APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS

A Simple Individual Hydrogen Sulfide Generator. L. K. YANOWSKI. *Chem.-Analyst*, **19**, 5, 17 (Sept., 1930).—The diagram shows the construction of a hydrogen sulfide generator which, due to its cheapness and ease of construction, is suitable for large laboratory classes. *A* is a Gooch crucible with a larger opening in the center through which the glass rod *B*, with a flange on one end, is inserted. The FeS is placed into the crucible and can be lowered into the dilute HCl or H_2SO_4 until the bottom of the crucible is just below the surface of the acid. A little vaseline on the rod *B* makes it easier to work and makes it gas tight. The gas flow stops very shortly after raising the crucible. If desired a pinchcock may be placed on the outlet, in which case a thistle tube should be introduced through a third hole in the rubber stopper to act as a safety valve. D. C. L.





A Simple Pump for Air under Low Positive Pressures. R. C. BRIMLEY. *J. Sci. Instr.*, **7**, 329 (Oct., 1930).—"An ordinary filter pump is connected to an aspirator bottle as shown, so that the stream of air and water separates out, the air leaving by the delivery tube *A* and the water flowing to waste through *B*. The maximum pressure depends on the height of the waste-pipe *B* but can be regulated by a constant head blow-off, if necessary. The rate of air flow must not exceed about one liter per minute which is almost the capacity of the filter pump. Excess air escapes through *B* with the water. The device will operate for long periods without attention and is quickly fitted up from apparatus on hand in the laboratory." R. L. H.

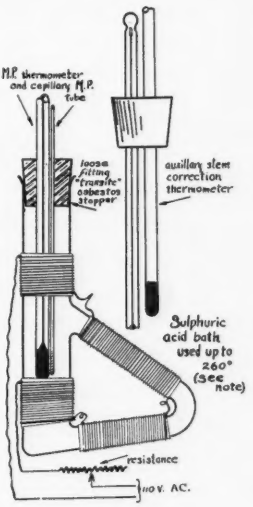
An Improved Volumetric Flask. W. NORMANN. *Chem.-Ztg.*, **54**, 744 (Sept. 24, 1930).—The adjusting of the temperature of a solution within an ordinary volumetric flask is a tiresome but necessary task for the preparation of carefully made standard solutions. This can be avoided if a volumetric flask, calibrated not for one particular temperature but for a whole range from 10–30°C., is used. Instead of adjusting the temperature of a solution it is only necessary to determine it by means of a thermometer and then to fill the flask to the proper mark. These flasks are manufactured by A. Dargatz, Hamburg, Germany. L. S.

A Convenient Form of Gas Combustion Pipet. E. W. R. STEACIE. *J. Am. Chem. Soc.*, **52**, 2811 (1930).—Advantages claimed: sturdy construction; no leakage; time of combustion shortened; adaptable to various volumes of gases. Drawing. H. H. K.

A Capillary Gas Valve. H. N. ALYEA. *J. Am. Chem. Soc.*, **52**, 1936–7 (May, 1930).—Description, with drawings, of a device useful in withdrawing extremely small samples of chlorine from a storage bulb. Might be applied in any case where the gas is easily liquified. H. H. K.

A Simple Electrically Controlled Thermostat. J. A. CRANSTON. *J. Chem. Soc.*, 1458–60 (June, 1930).—Description with drawing. Compactness and economy in use of electric current are claimed for the thermostat described. J. W. H.

An Electric Heated Thiel Tube. J. D. BURCHARD. *Chem.-Analyst*, **19**, 23 (Sept., 1930).—With the use of the Thiel tube in melting-point determinations, heating by licking the tube with the flame of the Bunsen burner may be troublesome, especially when the apparatus is to be housed in to avoid air drafts. The diagram shows a cheap and efficient means of heating. The resistance wire, having a resistance of about 2 ohms per foot, is wound around the tube on a single layer of asbestos paper at the points indicated. Wire from an old heating element may be utilized. When connected to a 110-volt alternating current, it should draw about 3 to 4 amperes, requiring about 20 feet of the wire. A wide temperature range can be attained by using a variable resistance. A stopper of transite asbestos board can be made by turning it down on a lathe. This does not char or chip. With a salt-sulfuric acid bath temperatures up to 380° can be reached. D. C. L.


M.P. thermometer and capillary M.P. tube
loose fitting "trumpet" asbestos stopper
auxiliary stem correction thermometer
Sulphuric acid bath used up to 260° (see note)
resistance
110 V. AC.

Phosphoric Acid for Determination of Melting Points. F. D. SNELL. *Ind. Eng. Chem., Anal. Ed.*, **2**, 287 (July, 1930).—If sirupy phosphoric acid is used in place of sulfuric in melting-point determinations between 100–300°C., hand stirring can be avoided. The apparatus with attached m.-p. tube is set up as usual. The phosphoric acid begins to lose moisture at about 100°C. By placing the burner a little to one side, the steam generated automatically creates a circulation. At 213° the ortho is converted to pyrophosphoric acid, and evolution of steam continues to almost 300°. On cooling, if 200° has not been exceeded about 10% water is stirred in below 100°, and it is ready for use. If heated higher more water is added. If contaminated by organic matter a crystal of KNO_3 is added. D. C. L.

The Preparation of Powdered Sodium. R. E. DUNBAR. *Chem.-Analyst*, **19**, 5, 6 (Sept., 1930).—Finely divided sodium for use in Claisen's, Wurtz-Fittig's, or similar reactions can be readily prepared by this method. A round-bottom Pyrex flask is provided with an air condenser about 75 cm. long. The sodium is freed from incrustations and oil and the desired amount cut into pieces so they can be slipped into the flask. It is then covered with xylene and heated with an electric heater until the sodium is completely melted, m. p. 97.5°. Any vaporized xylene is returned to the flask. When melted, the flask with condenser still attached is shaken vigorously, breaking the sodium into fine globules which have but little tendency to combine on cooling. The xylene and sodium can be separated by filtration on a Büchner's funnel. The small amounts of adhering xylene are usually not objectionable. D. C. L.

The Technic of Copper-Pyrex Tube Seals. H. W. B. SKINNER AND J. H. BURROW. *J. Sci. Instr.*, **7**, 290–1 (Sept., 1930).—A method for sealing copper tubing to Pyrex glass tubing is given. Since the glass has a coefficient of expansion only about one-half that of copper, the glass always cracks away from the copper upon cooling This was overcome by placing a layer of glass inside the copper as well as outside. Illustrated. R. L. H.

The Preparation of Anhydrous Oxalic Acid. E. I. JOHNSON AND J. R. PARTINGTON. *J. Chem. Soc.*, 1510–1 (June, 1930).—"Anhydrous oxalic acid is readily prepared by the following method. A mixture of 5 g. of the hydrated acid with 100 cc. of toluene, previously distilled over calcium chloride, is distilled in a wide-necked conical flask until about 15 cc. of liquid remain. The contents of the flask are submitted to filtration and the solid is washed with a little dry benzene. It is then kept in a vacuum desiccator over wax for 12 hours. The product is found by titration to be pure anhydrous oxalic acid. A conical flask is used since, during distillation, the anhydrous acid separates in small needles which adhere to the sides of the flask and are difficult to remove from an ordinary distilling flask. The method is probably capable of application, with suitable distilling liquids, in many other cases and an attempt is being made to obtain anhydrous periodic acid in this way. A similar method of using carbon tetrachloride has been described (Adams, "Organic Syntheses," **1921**, Vol. I, p. 67). Since toluene has a higher boiling point than carbon tetrachloride, its use will probably expedite the dehydration." J. W. H.

The Standardization of Weights. P. F. WEATHERILL. *J. Am. Chem. Soc.*, **52,** 1938 (1930).—"The accuracy of the Richards method [*J. Am. Chem. Soc.*, **22,** 144 (1900)] for the standardization of weights by substitution can be doubled by using the method of weighing by transposition. This latter method makes the use of a set of tare weights unnecessary, and involves no more time or difficulty than the Richards method. In fact, this is one operation to which the little-used transposition weighing seems peculiarly suited.

"If the weights W_1 and W_2 are to be compared, W_1 is placed on the left pan and W_2 on the right and the zero point noted. The weights are then reversed and the difference, d, necessary to bring the pointer to the same zero point is noted. It can be shown readily that $W_2 - W_1 = d(l_2)/(l_1 + l_2)$ where l_1 and l_2 are, respectively, the lengths of the beam to the left and to the right of the central knife edge. Since d is very small, any error introduced by assuming that $l_1 = l_2$ is entirely negligible, so $W_2 - W_1 = d/2$, where d may, of course, be either a positive or negative quantity. The method of calculating the corrections remains the same.

"Variations in the relative lengths of the balance arms are not likely to occur during any one comparison, and variations between comparisons could not affect the value of $W_2 - W_1$ appreciably." H. H. K.

Inorganic Lubricants. I. Amalgams. W. A. BOUGHTON. *J. Am. Chem. Soc.*, **52,** 2421–2 (June, 1930).—Description of process of making mercury and its liquid amalgams useful for stopcock and ground joint lubricants. H. H. K.

Inorganic Lubricants. II. Phosphoric Acid Mixtures. W. A. BOUGHTON. *J. Am. Chem. Soc.*, **52,** 2813–4 (July, 1930).—A method of preparing a phosphoric acid mixture containing chiefly meta-phosphoric acid. This mixture is not markedly hygroscopic and is useful as a stopcock lubricant. H. H. K.

Test Papers for Detecting Magnesium. I. STONE. *Science,* **72,** 322 (Sept. 26, 1930).—A convenient method for carrying out the new organic test for magnesium is by means of a spot reaction on filter paper impregnated with the reagent. White filter paper is immersed in a 0.001 per cent solution of paranitrobenzene-azo-resorcinol (ortho, para-dihydroxy-azo-paranitrobenzene) in alcohol and hung up to dry. To perform the test one drop of the slightly acid solution to be tested is placed in the center of the test paper and allowed to dry. Immerse paper in a dilute sodium hydroxide solution (about 1 per cent). In the presence of magnesium a blue spot will show in a reddish field. G. H. W.

Data for Time Reactions to Be Conducted by Students in the Laboratory. W. SEEGER. *Z. physik. chem. Unterricht,* **43,** 215–8 (Sept.-Oct., 1930).—The experiments outlined are planned to be performed by students and to show them the dependence of the reaction velocity on: concentration, temperature, and catalysts. The well-known reactions between hydrogen peroxide and hydriodic acid and between bromic acid and hydriodic acid are used.

The first series of experiments deal with the reaction shown by the equation: $H_2O_2 + 2HI = 2H_2O + I_2$. The following solutions are necessary: (1) a 1% solution of hydrogen peroxide. Dilute the commercial 3% solution with twice its volume of water. (2) A 1% solution of potassium iodide or hydrogen iodide. Dissolve 1 cc. of potassium iodide in a solution of 6 cc. of *N* HCl in 94 cc. of water. (6 cc. of *N* HCl decompose 1 g. of KI.) Hydriodic acid decomposes gradually in the light giving off iodine. Hence it is better to prepare a neutral solution of potassium iodide and to add the proper amount of hydrochloric acid to the solution of hydrogen peroxide. (3) A solution of 1 g. of acid-free wheat starch in 100 cc. of water.

In the first series of experiments the concentration of hydrogen peroxide remains constant, namely, 1%; that of potassium iodide is varied from 0.25 to 8%.

Each of six students takes two test tubes (18 cm. × 18 mm.) on which he marks off the volume of 10 cc. A third test tube of the same type is used for comparison and is filled with a blank solution made up by mixing 100 cc. of iodine solution (saturated at room temperature) with 10 cc. of filtered 1% starch solution and diluted with distillled water to 400 cc.

Each student fills his first test tube to the mark with a 0.1% solution of hydrogen peroxide. (Add 1 cc. of the 1% solution and dilute with water to the mark.) The second test tube is filled with potassium iodide solution of various concentration. A 10-cc. pipet graduated in 0.1 cc. is employed. The first student uses 0.25 cc.; the second, 0.5 cc.; the third, 1 cc.; the fourth, 2 cc.; the fifth, 4 cc.; and the sixth, 8 cc. Each student dilutes his potassium iodide solution to the mark with distilled water and adds 1 cc. of 1% starch solution by means of a pipet. The total volume of both solutions should be 21 cc.

When the instructor gives the signal the six students pour both solutions together at the same time, close the test tube with the thumb, shake quickly, and determine the time in seconds from the moment the solutions have been poured together to the moment when the intensity of the color is the same as that of the solution reserved for comparison in the third test tube.

The following results were obtained in one series of experiments:

First Series: 10 cc. + 1 cc. 1% Starch Solution. Temperature 19°C.

	Solution	*Time*
(*a*)	1% H_2O_2 + 0.25% KI	about 9 minutes
(*b*)	1% H_2O_2 + 0.5% KI	about 4½ minutes
(*c*)	1% H_2O_2 + 1% KI	140 seconds
(*d*)	1% H_2O_2 + 2% KI	70 seconds
(*e*)	1% H_2O_2 + 4% KI	35 seconds
(*f*)	1% H_2O_2 + 8% KI	17 seconds

In the second series the concentration of the potassium iodide solution was kept constant (1%) while that of the hydrogen peroxide was varied between the limits 0.25% and 8%. The technic was similar to that of the first series.

Second Series. Temperature 20°C.

	Solution	*Time*		*Solution*	*Time*
(*a*)	1% KI + 0.25% H_2O_2	8 minutes	(*d*)	1% KI + 2% H_2O_2	1 minute
(*b*)	1% KI + 0.5% H_2O_2	4 minutes	(*e*)	1% KI + 4% H_2O_2	30 seconds
(*c*)	1% KI + 1% H_2O_2	2 minutes	(*f*)	1% KI + 8% H_2O_2	13 seconds

The second reaction given by the equation: $HBrO_3 + 6HI = HBr + 3H_2O + 3I_2$ is employed in the same way. The following solutions are necessary: (1) A 1% solution of potassium bromate containing an equivalent quantity of sulfuric acid. (2) A 1% solution of potassium iodide containing an equivalent quantity of sulfuric acid. Hydrogen iodide decomposes in the light. Hence it is better to add twice the equivalent quantity of sulfuric acid to a 1% solution of potassium bromate (1 g. $IBrO_3$ + 88 cc. H_2O + 12 cc. *N* H_2SO_4) and to prepare a neutral 1% solution of potassium iodide. (3) A 1% solution of starch. (4) A blank solution to be used for comparison.

Third Series. Temperature 19°C.

	Solution	*Time*		*Solution*	*Time*
(*a*)	1% KI + 1% $HBRO_3$	16 minutes	(*c*)	1% KI + 4% $HBrO_3$	20 seconds
(*b*)	1% KI + 2% $HBrO_3$	140 seconds	(*d*)	1% KI + 8% $HBrO_3$	3 seconds

Fourth Series

(*a*)	2% $HBrO_3$ + 1% KI	160 seconds	(*c*)	2% $HBrO_3$ + 4% KI	40 seconds
(*b*)	2% $HBrO_3$ + 2% KI	80 seconds	(*d*)	2% $HBrO_3$ + 8% KI	20 seconds

Series 5 and 6 show the effect of catalysts and temperature.

Fifth Series. Total Volume 21 cc. as before

Solution	*Time*	*Temperature*
2% $HBrO_3$ + 1% KI	160 seconds	18°C.
2% $HBrO_3$ + 1% KI + 1 cc. *N* H_2SO_4	12 seconds	18°C.
2% $HBrO_3$ + 1% KI + 1 cc. 1% $FeSO_4$	15 seconds	18°C.
2% $HBrO_3$ + 1% KI	80 seconds	28°C.

Sixth Series. Total Volume 21 cc. as before

Alteration of Experiment 2b

1% KI + 0.5% H_2O_2	4 minutes	20°C.
1% KI + 0.5% H_2O_2 + 1 cc. *N* H_2SO_4	3½ minutes	20°C.
1% KI + 0.5% H_2O_2 + 1 cc. 1½ $FeSO_4$	10 seconds	20°C.
1% KI + 0.5% H_2O_2	3 minutes	30°C.

The following time reactions are recommended for further study: 1. The decolorization of a fuchsin solution by sulfurous acid. 2. The reaction between a solution of fuchsin in sulfurous acid and formaldehyde whereby a violet color is produced.

L. S.

Microscopic Methods in Analytical Chemistry. C. W. MASON. *Ind. Eng. Chem., Anal. Ed.*, **2**, 203–6 (July, 1930).—In many tests and operations conclusions are based almost entirely on what can be seen. With the microscope we can obtain a close-up of materials and processes which we ordinarily see as distant spectators. It helps to bridge the gap between the ordinary limit of visibility and the realm of atomic dimensions, and serves as a valuable aid to macroscopic analysis. Frequently, a substance may be identified at a glance, or shown to be a single substance or mixture. Molecular weights may be determined microscopically. Melting and transition points, hydration, and double salt formation are strikingly observable. Differences in behavior are often shown to be due to physical differences.

Under the microscope, all white precipitates are no longer alike, but often are so distinctive that further tests are unnecessary. Both qualitative and quantitative procedures can be greatly shortened. When once tried, one will be invited by the rapidity and directness of observations to make constant use of the microscope. Even if the primary question remains unanswered some additional information is always revealed and some light thrown on the interpretations of chemical phenomena. D. C. L.

Antifogging Agents in Developers. A. P. H. TRIVELLI AND E. C. JENSEN. *J. Franklin Inst.*, **210**, 287–309 (Sept., 1930).—As an antifogging agent in the hydroquinone, pyrogallol, and *p*-aminophenol developers, 6-nitrobenziminazole is superior to KBr and KI, giving the least depression of image densities with the same fog-removing quality. Investigations of G. Silberstein are to the effect that with negative films, 6-nitrobenziminazole in general does not give as good results as KBr. J. H. G.

Determination of Silver Ion with Various Concentrations of Hydrochloric Acid as Precipitant. F. G. GERMUTH. *J. Franklin Inst.*, **210**, 345–51 (Sept., 1930).—Experiments show that 0.15 *N* HCl solution is most suitable for employment as a precipitant in the quantitative estimation of Ag ion, this procedure reducing adsorption to a minimum. J. H. G.

Determination of Osmium. U. S. BUREAU STANDARDS NOTES. *J. Franklin Inst.*, **210**, 384 (Sept., 1930).—Reference is made to a new method of determination of osmium as presented in *Technical News Bulletin* Nos. 156 and 157, and the statement that the method offers a simple and accurate means for determination of this metal. A brief description of the method follows. J. H. G.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS

Rough Spots in Teaching Chemistry. R. LANGDALE. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 14–7 (Sept., 1930).—Stumbling blocks in the chemistry road are: 1. Distinction between polar and non-polar compounds. 2. The valence of *N* in ammonium compounds. 3. The marking of conductors in diagram. 4. The function of cryolite in Hall process, etc. There are 13 mentioned. O. C.

Organizing and Running a Chemistry Club. F. W. HANSON. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 11–4 (Sept., 1930).—Purpose of the Chemistry Club at Wilby High School, Waterbury, Conn., is: "For our mutual improvement, for the entertainment of our friends, for the cultivation of the amenities of social life, and to increase our knowledge of science and its applications."

The programs must be varied, failure is generally caused by continued sameness and by lack of interesting presentation.

A chemistry club brings a new interest in chemistry classes and an opportunity for the teacher to discover hidden ability, loyalty, and coöperation. O. C.

Talking Motion Pictures as an Aid in College Education. J. G. GLOVER. *Educ. Screen*, **9**, 201 (Sept., 1930).—Colleges have been handicapped in teaching modern methods in commerce and industry in that specialists in these lines will not give up their positions for the salaries offered by colleges. Now, however, specialists in all walks of life may be heard in our college lecture rooms.

The radio was the first step whereby students could hear any great speaker. Then the scientist was able to combine the photographed sound with motion picture, after the stereopticon proved but partially successful. Motion pictures were first used in the lecture halls as an aid in teaching in about 1919, by Prof. Cornell in his course on "Manufacturing Industries." It was difficult to find instructors with knowledge of the enormous industries, so with the advent of talking pictures, the problem is solved and opens a new era for education which will revolutionize our present methods. The student now will not only see and hear leading educators of this country but those from abroad who are authorities on their subjects. The classroom professor may aid the students by giving them a list of questions on the subject beforehand and requiring each

student to answer them afterward. "Teaching by means of motion pictures is a progressive step in education." H. T. B.

An Experiment in Teaching Laboratory Psychology by the Project Method. See this title on page 176.

ADMINISTRATIVE PROBLEMS AND DEVICES; CURRICULA

Administration of the High-School Science Program. W. W. CARPENTER. *High-Sch. Teacher*, **6**, 345–8 (Oct., 1930).—The author groups administrative duties into three classes; those that are immediately concerned with the teaching, those that are common to all teachers of the school, and those which concern only workers in particular departments. It is the third of these that is of particular concern to the science teacher.

For the science teachers he discusses; care of equipment and supplies, care of built-in equipment, distribution of equipment and supplies, storage, purchase, and accounting for equipment and supplies. Not the least of the science teacher's administrative tasks is that of making provision for the laboratory hazard. B. C. H.

A Problem in the Teaching of General Science. F. D. CURTIS. *Educ. Outlook*, **4**, 241–2 (May, 1930).—General science continues to hold an important place in the junior high school but capable teachers are not handling the job. The responsibility for adequately trained teachers rests with the teacher-training institution and the school administrator, the former to prepare and the latter to properly place. S. R. P.

KEEPING UP WITH CHEMISTRY

Behavior of Positive Ions in Hydrogen. A. C. G. MITCHELL. *J. Franklin Inst.*, **210**, 269–86 (Sept., 1930).—Experiments were performed to see whether fast positive ions are all able to dissociate hydrogen. In these experiments lithium and cesium positive ions of various velocities are produced in a tube containing hydrogen molecules. With ions of energies from 15 to 320 volts flowing in the tube, there is shown evidence of formation of some condensible product due to the action of the ions. The number of hydrogen molecules disappearing per positive ion entering the tube varies from 0.01 to 0.5. J. H. G.

Purification of Water by Electroösmosis. E. BARTOW AND R. B. JEBENS. *Ind. Eng. Chem.*, **22**, 1020–2 (Sept., 1930).—The purification of water by the removal of salts from a central section of a cell through diaphragms to cells containing anode and cathode poles has been developed in Germany. By passing the water from a central compartment of a series of cells, the water in this compartment becomes gradually purer until the anions and cations are practically all removed. The water so purified is claimed to be equivalent to distilled water and much cheaper. The authors obtained an apparatus from Germany to try out its applicability to local waters. The apparatus consists of ten cells placed side by side. The purified water passes by siphons through the central compartment of each cell. The anode and cathode water are removed by wash water. The current from a 110-volt generator is passed through the cells so that the potential increases as the water becomes purer. Tap water containing about 700 parts per million of zeolite-softened water gave about the same result. The chloride was reduced to zero, residues to about 14 parts per million, and resistance to about 26,000 ohms. About 90% of the ash from the residue from purified water was silica. Partially purified water containing 65 mg. per liter can be produced at a cost of 43 cents per hundred gallons at a rate of about 50 liters per hour. Less than one half the energy would be required to reduce the residue from 600 to 300, than from 300 parts per million to zero. The water produced is not of the desired quality until an hour after the machine is started. The residue being chemically inert, the water will serve for most of the common uses of distilled water. D. C. L.

Observations on the Priming of Saline Waters. J. S. HANCOCK. *Chem. & Ind.*, **49**, 369T–74T (Sept. 12, 1930).—Experiments are described which lead to the following conclusions. (*a*) At normal pressures suspended solids have no influence on priming. (*b*) Organic matter in presence of alkali may cause priming. (*c*) The sodium salts cause more priming than the corresponding potassium salts, and the acid radicals should be placed in the following order of decreasing influence; hydroxide, carbonate, sulfate, chloride, nitrate. E. R. W.

Smoke Abatement in U. S. A. H. B. MELLER. Reprint from *The Journal of the National Smoke Abatement Society*. Published by the Service Guild, 45 Deansgate Arcade, Manchester, for the National Smoke Abatement Society, 23 King St., Manchester, England.—Topics discussed are: the anti-smoke ordinance, effects of the anthracite strike, results of smoke abatement, and the problem of air pollution. R. L. H.

International Relationships in Chemical Manufacturing as Illustrated in the Development of a World-Wide Fixed Nitrogen Industry. H. A. CURTIS. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 7–11 (Sept., 1930).—The story of fixed nitrogen traced from the fourteenth century to the present. Production in India, South America, Germany, and United States described. O. C.

The Nitrogen Industry and Our Food Supply. R. E. SLADE. *Chem. & Ind.*, **49**, 760–6 (Sept. 12, 1930).—Thirty-two years ago Sir William Crookes said: "The fixation of nitrogen is vital to the progress of civilized humanity"; and again, "The fixation of nitrogen is a question of the not far-distant future. Unless we can class it among the certainties to come, the great Caucasian race will cease to be the foremost in the world, and will be squeezed out of existence by the races to whom wheaten bread is not the staff of life." In 1928, 1,843,000 tons of nitrogen were used in the world, 1,658,000 tons being used in fertilizers. More than one-half of this was produced in nitrogen-fixation plants. Interesting tables and graphs show the results of the increased use of nitrogen. E. R. W.

The New Kingdom of Ammonia. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 46 (Oct., 1930).—A brief survey article including statistics indicating the increased significance of ammonia during the last six years, and suggestions for possibilities for increased use in the future. R. L. H.

Nitric Acid Produced from Ammonia by Modified Pressure System. G. FAUSER. *Chem. & Met. Eng.*, **37**, 604–8 (Oct., 1930).—The author gives in this article a description of the most favorable conditions for economical conversion of ammonia into nitric acid. The per cent of conversion of ammonia to nitric oxide is greatest at 850°C. and atmospheric pressure, while the rate of oxidation of NO to NO_2 is increased with increase in pressure and decrease in temperature. The ammonia is first oxidized at atmospheric pressure and the NO later compressed for further oxidation. R. L. H.

Atomic Hydrogen Welding. C. I. MACGUFFIE. *Balto. Eng.*, **5**, 15–6 (Aug., 1930).—The process of atomic hydrogen welding was discovered and developed by Irving Langmuir. The heat carried from an incandescent filament by an inert gas is increased by 1.9th power of the temperature of the filament. There were abnormal results noticed when hydrogen was used, which were found to be caused by the dissociation of the hydrogen molecules into atoms. The temperature given by the atomic hydrogen flame is about 4030°C. The reducing action of hydrogen makes the atomic hydrogen flame ideal for welding. R. L. H.

Aluminum in the Chemical Industry. H. V. CHURCHILL. *Ind. Eng. Chem.*, **22**, 993–5 (Sept., 1930).—The term aluminum is often applied indiscriminately to any metal which has aluminum as the principal constituent, so that there may be a wide range in properties in the various alloys which are referred to as Al. Small amounts of Si, Fe, and Cu are present in most Al, and Mn, Mg, and Zn are often added to give desired properties. The purest Al is most resistant to chemical attack and is used in chemical apparatus where solutions are neutral or but slightly acid, unless the presence of Al is not objectionable. Practically no Al salts color solutions, so Al is often used where Fe or Cu containers would color the product. In the production of citric and gluconic acids by fermentation, Al containers are used because the Al salts are not toxic to those ferments. Al is not resistant to alkaline attack, but it is used in ammonia condensers in by-product coke plants. It is used in the turpentine rosin and varnish industries on account of the favorable color when the premium on color is sufficient to warrant the extra cost. On account of its high position in the electromotive series, Al should be used by itself, and not in contact with other metals. When subjected to high temperatures there is no serious oxidation or scaling. The thermal conductivity of solid solutions drops to more than one-half that of the pure Al, while in brasses and bronzes it often drops to 0.25–0.10 that of pure Cu. Al paints are used in solving lighting problems and on tanks where reflection of heat is desired. Al foil is also used for the same purpose, the foil being fastened by asphaltic or bituminous adhesives. D. C. L.

Tung Oil in Mississippi. H. BRYANT. *Mfgrs. Record*, **98**, 54 (Nov. 13, 1930). R. L. H.

The "Cellulose Age" Dawns in the South. G. M. ROMMEL. *Mfgrs. Record*, **98**, 42–3 (Nov. 13, 1930). R. L. H.

Swedish Iron Ore: Mining and Transport. B. H. STROM. *Eng. Mining J.*, **130**, 381–6 (1930).—North of the Arctic Circle at 68 degrees latitude are the iron deposits of Lapland, the largest in Sweden and among the largest in the world. With the present rate of shipment, about 9 million tons per year, the deposits are assured of a life of 150 to 200 years. The ore is of a high quality, the iron content varying from 58 to 70 per cent, with a very low sulfur content. Part of the ore is almost entirely free from phos-

phorus. The greater part of the ore is a hard compact magnetite generally containing some apatite. Most of the ore mined in Lapland is shipped abroad. G. W. S.

Is Gray Iron on a New Basis? J. S. VANICK. *Inco*, **10**, 12–3 (1930).—"Gray iron is today the most quickly made, most readily procurable, and cheapest casting metal available for machinery and engineering applications."

Yet the demand for cheaper and cheaper cast iron has operated to stifle improvement of operation or of product. "An industry working upon a slender or a vanishing profit could hardly be expected to expend itself studying its consumer's requirements."

For some reason, not fully analyzed, there seems to be a turn for the better. Some of the advantages coming to the user of better quality cast iron are enumerated as: fewer defective castings, more rapid machining of such castings, elimination of annealing as a production cost, longer life to the better grade casting, higher corrosion resistance, and general increased service. The most promising method of improvement seems to be in the direction of alloying the product. B. C. H.

Quarrying Rock Asphalt in Texas. C. H. VIVIAN. *Compressed Air Mag.*, **35**, 3244–7 (Sept., 1930).—An interesting, well-illustrated description of the quarrying and uses of natural occurring mixtures of rock and asphalt. E. R. W.

Preservation of Rubber Goods by Antioxidants. T. L. GARNER. *Chem. Age*, **23**, 252–3 (Sept. 20, 1930).—A discussion of the general theory of antioxidants, and the preservation of rubber goods by antioxidants. E. R. W.

Crystalline Rubber. U. S. BUREAU STANDARDS NOTES. *J. Franklin Inst.*, **210**, 509 (Oct., 1930).—The Bureau has recently developed a process by which pure rubber can be repeatedly crystallized, thus opening the possibility of successfully fractionating it into its constituent hydrocarbons and eventually determining the formulas of their molecules. The method of doing this is described. J. H. G.

Chemical Warfare Training in the Army. W. N. PORTER. *Chem. Warfare*, **16**, 802–13 (Aug.-Sept., 1930).—An outline of the method by which information relating to chemical warfare is disseminated throughout the army. E. R. W.

Dyes and Their Application: Recent Technical Progress. L. J. HOOLEY. *Chem. Age, Dyestuffs Mo. Suppl.*, **23**, 21–2 (Sept. 13, 1930).—A discussion of benzanthrone dyes. E. R. W.

Another Land of Promise. ANON. *Ind. Bull. Arthur D. Little, Inc.*, No. 46 (Oct., 1930).—The potential resources of the southeastern portion of the United States are outlined. R. L. H.

Vermont a Notable Producer of Talc. A. S. TAYLOR. *Compressed Air Mag.*, **35**, 3282–6 (Oct., 1930).—The use of talc in the manufacture of talcum powder is of relative insignificance compared with its use in other industries. Chief among these are the manufacture of crayons for metal marking, paper, insulated wire, roofing paper, rubber, paint, linoleum, and glass. The illustrated article contains a description of the occurrence, methods of mining, and uses of talc. E. R. W.

Crystalline Talc. F. R. WICKS. *Eng. Mining J.*, **130**, 319–21 (1930).—Chemically pure talc is a crystalline hydrous magnesium silicate and is one of the most inactive chemical substances known in nature. It is believed that the deposit in southeastern California is the only workable deposit of crystalline talc in North America. Although talc is usually thought of in connection with the manufacture of cosmetics and talcum powders, it finds a good many other uses among which are its uses in the ceramic industry for the manufacture of white tile and electrical porcelains; in the manufacture of rubber products for the dusting of molds and finished goods and sometimes incorporated in the product itself; in many dry lubricants and heavy oil lubricants; in concrete where it serves to produce a workable and plastic mixture with less water and in paper products and paint. The standard of fineness for most uses is the 200-mesh screen. Details of mining and mechanical treatment are given. G. W. S.

Aladdins of the Test Tubes. W. P. HELM. *Colliers*, **86**, 20 (Oct. 11, 1930).—An American manufacturer was left with 62,000 tons of smokeless powder at the end of the World War. By the magic of test tubes, retorts, acids, and alkalis his chemists turned this into a liquid, splashed with a rainbow of color, and used it to paint automobiles. A new industry had sprung up from the dumps.

Since then the chemist with seven-league strides has crossed the frontiers of the unknown, rolling back its clouds and shadows, and revealing flashes of vast opportunity. The modern chemist is the Aladdin of industry. The things that are useless he turns to gold. Wherever there is waste one finds him seeking to save it.

Among the special examples cited are the recent work on cornstalks including their use as an absorbent for explosives; the preparation of xylose from cottonseed hulls;

liquefaction of coal; the manufacture and uses of diphenyl to keep down pressure in boilers.

In 1929 alone the printed index of what was done in chemical research, set in agate type, two columns to the printed page, covers nearly 2000 generous pages.

J. W. H.

What Won't They Do Next? J. T. FLYNN. *Am. Mag.*, **110**, 24–5 (Oct., 1930).—The author in an interview with Willis R. Whitney shares with the reader some of the future achievements of science as the director of research for the General Electric Laboratories visions them. Possibilities of pilotless airplane navigation, of a widespread use of television, of useful fevers induced by electricity, of the photoelectric cell "in the harness," and the generation of vitamins by cathode rays were the subjects included in the interview.

Doctor Whitney is characterized as the research worker who "loves to tinker with uncertainties; . . . (who) is primarily interested in the unknown . . . (and who when he) discovers some fragment of the unknown . . . is no longer interested in it" because it is known.

B. C. H.

When You Need Iodine. W. H. EDDY. *Good Housekeeping*, **91**, 116–8 (Sept., 1930).—The thyroid glands of the neck require iodine in the diet if they are to function properly. Deprived of this element in the food supply this gland enlarges to an unsightly lump called a goitre.

To prevent this affliction, then, becomes a matter of diet. Experiment has shown that the addition of iodine to the diet reduces the chances of goitre. In some regions the vegetables can be relied upon to furnish the small amount of iodine required but that is not universally true so a knowledge of other sources of iodine is essential.

The Department of Commerce, Bureau of Fisheries, Document No. 967 says, "The data indicate that marine fishes, mollusks, and crustaceans contain a higher percentage of iodine than any other common foods. Oysters, clams, and lobsters contain more iodine than any other marine food. . . . Oysters, clams, and lobsters contain about 200 times as much iodine as milk, eggs, or beefsteak."

Experiments are under way for enriching the iodine content of vegetable foods, such as spinach, by introducing more iodine in the soil. Efforts are also being made to get a higher iodine content into the cow's milk through the diet.

B. C. H.

Chemical Industries. See **Aladdins of the Test Tubes** on page 171.

Resources of the South. See **Another Land of Promise** on page 171.

Future Achievements for Science. See **What Won't They Do Next?** above.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Chemical Atoms and Superatoms. E. J. WITZEMAN. *Sci. Mo.*, **31**, 350–60 (Oct., 1930).—An attempt to trace the relationship between the simple atoms of chemistry and the so-called superatoms which are sufficiently large to be visible as morphological units in the living organism. It is pointed out that both chemical radicals and chemical atoms possess complex organizations and can and do function as a unit, that in solution both have associated with them more or less water, that amino acids are built up into structures having a molecular weight of 30,000 and upward in water and in most cases have a high affinity for water. The protein molecule, therefore, becomes an enormous polyvalent amphoteric electrolyte. From this W. traces possible steps that might be taken in the building up of definitely oriented structural patterns by which these superatoms achieve, and are endowed with, special physical and chemical functions in the cell.

G. W. S.

HISTORICAL AND BIOGRAPHICAL

Louis Munroe Dennis. A. W. BROWNE. *Ind. Eng. Chem.*, **22**, 1257–8 (Nov., 1930).—An appreciation with portrait. One of American contemporaries.

D. C. L.

Prof. H. B. Dixon. W. A. BONE. *Nature*, **126**, 511–2 (Oct. 4, 1930).—An obituary of the late Professor Harold Bailey Dixon of the University of Manchester.

Professor Dixon was born in 1852 and was educated at Oxford, taking first class in the Natural Science Group in 1875. After holding a Fellowship at Oxford, he succeeded in 1886 Sir Henry Roscoe in the chair of chemistry at Owens College, Manchester. This he held until his retirement in 1922, though he carried on investigations until his death, September 18, 1930. Professor Dixon is known to chemists, especially on account of his important and accurate work upon the rate and nature of gaseous explosions, on the effect of prolonged drying of gases upon their reactivity and upon ignition temperatures of explosive gases media.

F. B. D.

The Seventieth Birthday of Friedrich Emich. G. JANTSCH. *Chem.-Ztg.*, **54,** 685–6 (Sept. 3, 1930).—Dr. Friedrich Emich celebrated his seventieth birthday on September 5, 1930. He was born in Graz as the son of an engineer, attended the Oberrealschule at Laibach, and studied chemistry under R. Maly at the Polytechnic Institute of Graz. From 1885 to 1889 he was teaching at the Girls' High School at Graz. In 1888 he joined the faculty of the Polytechnic Institute at Graz where he has remained to this day. It was there that he conducted his fundamental microchemical researches.

His first work dealt with the properties of gallic acid, biguanides, guanidine, and the amides of carbonic acid. Then he turned to inorganic chemistry. He became interested in nitric oxide, the imflammability of thin layers of explosive gas mixtures, and density determinations of gases at high temperatures. He prepared and studied titanium tetrafluoride. In 1893 he devoted his attention to the field of microchemistry and microanalysis which was little known at that time. From then on this field became his chief interest. It is due to him that today there are methods employed in the field of inorganic chemistry which allow the detection and determination of very small quantities of material.

His first microchemical paper published in 1893 dealt with the determination of sulfur by oxidation with bromine and precipitation as calcium sulfate. Later he worked out microchemical methods of determining boric acid, heavy metals, rubidium, cesium, aluminum, zinc, mercury, sulfur, carbon, nitrogen, and others. By the use of very small centrifuge tubes and capillary tubes he developed a method of separating and analyzing extremely small quantities of materials (0.01 mg.). All kinds of operations were performed within the capillary. He simplified the construction of the micro-balance and increased their sensitivity. He constructed a Nernst balance with a sensitivity of 0.1 $\times 10^{-3}$ mg. and an electromagnetic balance having a sensitivity of 0.15 $\times 10^{-4}$ mg.

Besides numerous articles Dr. Emich has published the following two books "*Lehrbuch der Mikrochemie*" and "*Mikrochemisches Praktikum.*" L. S.

The Seventieth Birthday of Friedrich Emich on September 5, 1930. W. BOTTGER. *Z. angew Chem.*, **43,** 791 (Sept. 6, 1930).—A biography. L. S.

Dr. Moses Gomberg. *Sci. Mo.*, 380 (Oct., 1930).—Portrait of president of the American Chemical Society for 1931. G. W. S.

Fritz Haber on His 60th Birthday. *Naturwissenschaften*, **16,** 1051–78 (Dec. 14, 1928).—Entire number is devoted to the life and work of Fritz Haber. Contains excellent portrait as frontispiece. M. W. G.

Dr. Arthur Harden. *Sci. Mo.*, 466 (Nov., 1930).—Portrait of Dr. Harden in his laboratory. Dr. Harden is professor of biochemistry at London University and head of the department of biochemistry at the Lister Institute. He shared with Professor Hans von Euler the Nobel prize in chemistry for 1929. G. W. S.

(Ellwood) Hendrick: The Great Explainer. EDIT. *Chemist*, **8,** 3–4 (Oct., 1930).—An appreciation of Ellwood Hendrick, who died of pneumonia, October 29, 1930. R. L. H.

Richard Kirwan, an Irish Chemist of the Eighteenth Century. J. REILLY AND N. O'FLYNN. *Isis*, **13,** 298–319 (1930).—The Irish chemist and mineralogist, Richard Kirwan (1733–1812), wrote on a variety of subjects; divinity, metaphysics, logic, law, philology, music, mechanics, chemistry, mineralogy, mining, geology, and meteorology. He was a friend of Cavendish, Priestley, Ingenhouz, Cavallo, Black, and of many other men of science, and was honorary member of the Academies of Stockholm, Upsala, Berlin, Dijon, Philadelphia, and of the Mineralogical Society of Jena. He was Fellow of the Royal Societies of London and Edinburgh, honorary member of the Manchester Society, and president of the Royal Irish Society from 1799 until the time of his death. He published "Elements of Mineralogy" (1784), "An Essay on Phlogiston and the Constitution of Acids" (1787), and "Analysis of Mineral Waters" (1799). The "Essay on Phlogiston" was a vigorous defence of the doctrine. It was translated into French and the several portions of it were supplied with replies by Lavoisier, Berthollet, Fourcroy, Morveau, and Monge. The French edition, with its notes, replies, etc., was translated into English and published in London in 1789. In 1791, in a letter to Berthollet, Kirwan admitted his acceptance of the new chemical theory and offered to give a refutation himself to his own "Essay on Phlogiston." The present article is accompanied by a portrait of Kirwan and a list of his papers in the *Philosophical Transactions* and in the *Proceedings of the Royal Irish Academy.* T. L. D.

Dr. Irving Langmuir and Dr. A. W. Hull with the Thyration Power Tube. *Sci Mo.*, 382 (Oct., 1930).—Portrait. G. W. S.

Dr. William McPherson. *Sci. Mo.*, 379 (Oct., 1930).—Portrait of president of the American Chemical Society, 1930. G. W. S.

Charles Moureu. *J. Am. Chem. Soc.*, **52**, 31–5 (May, 1930).—An obituary with portrait. H. H. K.

William Henry Nichols. *J. Am. Chem. Soc.*, **52**, 47–50 (June, 1930).—An obituary with portrait. H. H. K.

Theodore William Richards Memorial Lecture. H. HARTLEY. *J. Chem. Soc.*, 1937–69 (Aug., 1930).—An account of Richards' life and work. Two portraits. J. W. H.

Karl Wilhelm Scheele. L. H. RODDIS. *J. Am. Pharm. Assoc.*, **19**, 1017–9 (Sept., 1930).—A brief account of the Swedish apothecary scientist of the 18th century. Article contains illustrations of the Scheele corner in the Northern Museum at Stockholm, birthplace of Karl Wilhelm Scheele, and Scheele's apotheke. R. L. H.

Paul Wagner. H. ROESSLER. *Chem.-Ztg.*, **54**, 697 (Sept. 6, 1930).—Dr. Paul Wagner, who died at the age of 88, was born at Liebenau and studied at the Universities of Erlangen and Göttingen. In 1872 he was appointed director of the newly founded Agricultural Experiment and Control Laboratory of Darmstadt where he remained until October, 1923.

During the fifty odd years of his connection with this laboratory he expanded the teachings of Liebig in the field of fertilizers and the cultivation of plants. He improved the methods employed for experimentation with plants, and was the pioneer of the artificial fertilizer industry.

He was the first one to discover that the Thomas slag obtained from iron ores represented a valuable fertilizer. He also conducted numerous experiments with calcium cyanide and developed directions for its use. He published a large number of articles on the effect of potassium on plants. L. S.

Willis R. Whitney. See **What Won't They Do Next?** on page 172.

Doctor Harvey W. Wiley. EDIT. *Good Housekeeping*, **91**, 4 (Sept., 1930).—A belated tribute to the Director of the Bureau of Foods, Sanitation, and Health of *Good Housekeeping* by its editor. The occasion of the editorial was the death of Doctor Wiley on June the thirtieth of the current year.

Doctor Wiley is characterized as the soul of integrity. He is further described as having simplicity, honesty, truth, honor, and strength. From a farm boy upon an Indiana farm he grew to become a fighter for the purity of a nation's food supply. So well did he succeed that he was interred with the nation's honored dead at Arlington. B. C. H.

Some Scientific Instrument Makers of the Eighteenth Century. R. S. WHIPPLE. *J. Sci. Instr.*, **7**, 241–52 (Aug., 1930); *ibid.*, 273–81 (Sept., 1930).—*Cf.* J. CHEM. EDUC., **7**, 2193, 2996 (1930). R. L. H.

Solution of the Jabir Problem. J. RUSKA. *Archeion*, **12**, 163–5 (1930).—Ruska believes that the writings which have been described to Jabir are Isma'ilite compilations of the ninth and tenth centuries. T. L. D.

Seven Salts of Hermes. L. THORNDIKE. *Isis*, **14**, 187–8 (1930).—An enumeration of the seven *magisteria* in an alchemical manuscript probably of the thirteenth century. T. L. D.

Testing of Substances among the Ancients. M. STEPHANIDES. *Archeion*, **11**, 375–94 (1930).—This well-documented article deals with such matters as testing by means of the senses, testing by mechanical means, testing by the fire and in solution, testing of minerals and metals, testing of waters, and the testing of various other products such as oil, honey, butter, vinegar, perfumes, flour, urine, and medicines. Of particular interest is the test, recommended by Dioscorides, in which a piece of papyrus previously soaked in the juice of nut-galls is dipped into a liquid which is suspected of containing iron. A black color on the papyrus indicates the presence of iron. This is perhaps the earliest case of the use of test paper. T. L. D.

The Greatest Dates in History. H. G. WELLS. *Forum*, **84**, 269–72 (Nov., 1930).—Of 15 dates given not one is directly concerned with a discovery in science. S. A. L.

The Story of Fixed Nitrogen. See **International Relationships in Chemical Manufacturing as Illustrated in the Development of a World-Wide Fixed Nitrogen Industry** on page 170.

Glass. ANON. *Silicate P's & Q's*, **10** (Oct., 1930).—Glass is a product of research. Sometime in the past in Mesopotamia, there lived a man who was more curious than his neighbors. His greatest pleasure was in trying to understand the world about him. One day, perhaps, he fell asleep while tending a fire under a baking oven. Awakening, he saw the bricks covered with glistening material. Remembering the source of the materials that went into the fire, and developing the hint thus brought to him, he learned to assemble the soda and white sand and to make a glass. Research is still going on.

The methods used in the past are now antiquated—ours, too, will be displaced by better. Our work must have behind it a note of idealism, a philosophy of life which makes our tasks seem worth doing. H. T. B.

Microchemistrys. See **The Seventieth Birthday of Friedrich Emich** on page 173.

EDUCATIONAL MEASUREMENTS AND DATA

Educational Tests for Use in Institutions of Higher Learning. J. S. KINDER AND C. W. ODELL. *Univ. Ill. Bull.*, **27**, 1–95 (Aug. 5, 1930).—The first 17 pages of this bulletin are devoted to introductory remarks on the following topics: the present status of standardized educational tests in institutions of higher learning, limitations on the use of achievement tests in these institutions, the purposes to be attained by the use of these standardized tests, planning a testing program, criteria for selecting tests, the present interest in examinations, especially those of the objective type, the comparative advantages and disadvantages of standardized tests and examinations constructed by classroom teachers, the administration of standardized tests, the literature on testing in higher education.

The second portion of the bulletin, pages 18–52, is devoted to a list of recommended tests classified according to subject. The tests listed for chemistry are:

Columbia Research Bureau Chemistry Test
Forms A and B

This is a comprehensive and thorough test based upon information found in most high-school and college texts. It is divided into three parts. Part I contains about 50 per cent of the test and deals with descriptive information; Part II has about 30 per cent and is devoted to formulas and equations; Part III embraces about 20 per cent and consists of problems. Norms are based upon eight thousand cases. 110 minutes.

Specimen set 20c, $1.50 per 25.

World Book Company, 110 West Peachtree Street, Atlanta; 14 Beacon Street, Boston; 2126 Prairie Avenue, Chicago; 1307 Pacific Avenue, Dallas; Manila, P. I.; Yonkers-on-Hudson, New York; Portland, Oregon; 149 New Montgomery Street, San Francisco.

Iowa Placement Examinations, Revised, Chemistry
Series CA1—Aptitude and CT1—Training; Forms A and B of each

This series is designed especially for college freshmen, to be used before or soon after the opening of the college term. The aptitude test consists of four parts: simple arithmetic of chemistry, ability to secure precise data from chemical paragraphs, chemistry reading comprehension, interesting chemistry (measured by accuracy of common information). The training series consists of the following parts: knowledge of fundamentals of chemistry, valence, formulas, and equations, manufacturing processes, fundamental chemical problems. 44 minutes each.

Bureau of Educational Research and Service, Extension Division, State University of Iowa, Iowa City, Iowa. Specimen set 45c; $3.50 per 100.

Moss-Loman-Middleton-Hubbard General Chemistry Test (George Washington University Series)

The content of the first-year general chemistry course in college is covered. The test is composed of five subtests: completion or mutilated sentences, writing formulas, true-false statements, completing and balancing equations, solving problems. 45 minutes.

Center for Psychological Service, 2024 G Street, N. W., Washington, D. C. 7c per copy, $5.00 per 100.

Noll Tests in General Inorganic Chemistry
Achievement and Laboratory Tests

The Achievement Test is intended to be used to classify students entering a beginning course in college chemistry, or to measure those who have completed the course. The Laboratory Test is designed to measure some of the more intangible outcomes of laboratory instruction and may be used either alone or along with the Achievement Test. Its three parts deal with laboratory technic and information, the drawing of simple apparatus and diagramming of the set-up of apparatus required in particular experiments. Only tentative norms are available. Achievement Test, 100 minutes; Laboratory Test, 60 minutes.

V. H. Noll, University of Minnesota, Minneapolis, Minn. Achievement Test, 6c per copy. Laboratory Test, 4c per copy.

Roe-Hunt-Stubbs-Hubbard Organic Chemistry Test (George Washington University Series)

This covers the material of the first college course in organic chemistry. Part 1 measures knowledge of structural formulas; Parts 2 and 3, general information in the field of organic chemistry, including knowledge of principles, knowledge of compounds, and ability to balance equations; Part 4. ability to solve problems. Norms are available for college groups. 45 minutes.

Center for Psychological Service, 2024 G Street, N. W., Washington, D. C. 7c per copy, $5.00 per 100.

The third part of the bulletin, pages 53–93, is devoted to a selected and annotated bibliography.

An appendix of publishers' addresses will be found on pages 94–5.

Address all communications regarding this bulletin to the Bureau of Educational Research, University of Illinois, Urbana, Illinois. R. L. H.

An Experiment in Teaching Laboratory Psychology by the Project Method. M. SHIRLEY AND K. HEVNER. *J. Applied Psychol.*, **14**, 309–54 (Aug., 1930).—An experiment to determine the relative advantages of the routine method and a project method of teaching scientific method and statistical analysis in psychology. Two groups of students taught by each method were compared. The outline of the course is presented and the teaching procedure. Tables present the results of the experiment. Some conclusions are: (1) Students taught by the project method do as well as those taught by the regular method when measured by objective tests. (2) The method is somewhat more successful when students who enjoy original work are allowed to select their own projects and other students go on with the regular work. (3) For the superior student either method is successful. (4) For the "average" student one method is as good as the other. (5) For the "inferior" student both methods fail. (6) The project method is especially valuable for the "discrepancy" student of more than average ability but with little interest in the rigid cut-and-dried course work. S. R. P.

A Comparison of Colored and Uncolored Pictures. W. P. MACLEAN. *Educ. Screen*, **9**, 196–9 (Sept., 1930).—In an experiment to determine whether colored pictures were superior to similar pictures uncolored, 152 boys of J. Sterling Morton High School of Cicero, Ill., were used. There were 76 in the experimental group and 76 in the control group. Two direct questions were asked concerning each of 10 pictures. It was found that colored pictures were decidedly superior where natural scenery and costumes play an important part. For the other pictures, the uncolored produced nearly equal or slightly superior results. In 9 cases of 20, the colored pictures were superior for determining the correct answers; in 5, the uncolored were superior; and in 6, there was very little difference. Of the colors used, red attracted the most attention for the amounts used. "The colored pictures produced a greater range and accuracy of report with 57% of the 152 subjects." H. T. B.

Bugaboos in Education. See this title below.

Rating of Teachers. See this title on page 177.

THE PHILOSOPHY OF EDUCATION

Bugaboos in Education. H. L. BUCK. *Sch. Exec. Mag.*, **50**, 5 (Sept., 1930).—A discussion of the way in which intelligence tests, class size, and pupil load, ability grouping, rating of teachers, achievement testing, and pension systems have worried the teacher. "As a result of our unrest and hectic search, we may at last believe that teaching is standardized at the expense of real education, that education is not and never can be quantitative. Standardized facts and objective data are only incidental, the qualitative development is vital. For education in its last analysis is life and life is a spiritual adventure." J. W. H.

Whose Children Are They? H. C. MAYER. *Forum*, **84**, 294–9 (Nov., 1930).—An educator sharply criticizes the effort of the schools to monopolize the training of the child. The home is a powerful influence in modern society, hence, instead of ignoring it, as they have endeavored to do, the schools should genuinely coöperate with the home. "Parents have an important contribution to make which no teacher or school system will ever be able to provide." S. A. L.

THE PHILOSOPHY OF SCIENCE

What Is Science? C. M. JACKSON. *Sigma Xi Quart.*, **18**, 77–86 (Sept., 1930).—Science is a field of human endeavor which, together with philosophy, covers the field of the universe. It makes use of observation, classification, organization, and generalization; and is motivated by the desire to aid in the promotion of human welfare, and by the human trait of "scientific curiosity."

"The dividing line between science and philosophy is not vertical and sharply defined. The division is rather to be thought of as horizontal in character. All branches of knowledge have a lower zone of verifiable scientific facts, and a higher zone, as yet unverifiable, of philosophic hypothesis." H. T. B.

PROFESSIONAL

Rating of Teachers. J. J. PHILLIPS. *Ohio Teacher*, **50,** 189–90 (Jan., 1930); *ibid.*, 223 (Feb., 1930).—A superintendent tells what he considers when rating teachers.

How the child develops morally is one phase discussed and the writer gives what he considers indications that attention to such development is given.

Personal appearance, sense of humor, how the supervised study is conducted, the teacher's sense of relative values, coöperation, the voice, punctuality, personal growth, self-control, and sincerity are other phases discussed. S. R. P.

Helping the High-School Teacher. M. A. NORTON. *Ohio Teacher*, **50,** 209–10, 226 (Feb., 1930).—The writer states and discusses the five greatest needs of the high-school teacher. They are: (1) a philosophy of life which includes a philosophy of education; (2) a broad sociological background; (3) content and method in the specific subject; (4) working knowledge of psychology; and (5) an understanding of the particular pupils and community. It is believed that much of the information needed must be obtained on the job. S. R. P.

Our Hermit Professors. G. A. BLACKBURN. *Sch. Exec. Mag.*, **50,** 115 (Nov., 1930).—One of the most disconsolate facts with respect to higher education is the universal low opinion commonly held toward college teachers. Professors are notoriously absent-minded, impractical, improvident, and shrink from the rough contacts with harsh realities of the world of affairs. In defense they say, "We are the custodians of the world's knowledge, the idealists, dreamers, and thinkers."

In doing this it is charged they have made the college campus too much like a monastery and not a place of sympathetic and animated observation of bustling human life. They have too often made impracticability the test of culture. Instead of regarding education as a preparation for life, they sometimes give the impression of regarding life as a stage set for the exhibition of clever little things learned in school.

When the college professor is in closer touch with the life around him he is better fitted to teach young students who come under his tutelage. J. W. H.

Schoolroom Learning. F. MATEER. *Ohio Teacher*, **50,** 181–2 (Jan., 1930).—An article concerning the unstable teacher. Symptoms are described, causative details and some ways to obviate these. Talking too much and indecision are two of the prominent symptoms. Some factors causing instability on the part of the teacher are lack of orderliness, quietness, and haste. Instability of the teacher motivates the same condition in the child. S. R. P.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Report of National Advisory Committee on Education. See **An Historical Educational Document** below.

An Historical Educational Document. J. H. NEWLON. *Sch. Exec. Mag.*, **50,** 70 (Oct., 1930).—A brief survey of the first report made by the National Advisory Committee on Education July 4, 1930. Three tentative recommendations of major importance are made (1) The Federal Government has an obligation to aid public education in the states, (2) The Federal Government should extend financial aid to education in the states but in a manner that will not violate other fundamental educational, political, social, and economic considerations basic to sound public policy, (3) adequate federal headquarters for education should be established. J. W. H.

Some Remarks Apropos of the Project of Reform of the Nomenclature of Organic Chemistry. V. GRIGNARD. *Bul. soc. chim. Romania*, **12,** 115–21 (Jan.-Apr., 1930).—A report made before the annual conference of *l'Union Internationale de la Chimie.* M. W. G.

The American Association for the Advancement of Science: Joint Meeting of the Executive Committee of the American Association and the Executive Committee of the Pacific Division. *Science*, **72,** 371–2 (Oct. 10, 1930). G. H. W.

The National Academy of Sciences. *Science*, **72,** 372–8 (Oct. 10, 1930).—Papers presented at the autumn meeting of the National Academy of Sciences held in California from September 18th to 23rd which are probably of interest to chemists were:

Circulation of the waters of the Pacific Ocean as indicated by their physical and chemical properties, E. G. MOBERG.

On the favorable action of certain fats and of the glycerides of certain single fatty acids on animals deprived of vitamin B, H. M. EVANS and S. LEPKOVSKY.

The origin of limestone caverns, W. M. DAVIS.

On the production of high-speed protons, E. O. LAWRENCE and N. E. EDLEFSEN.

The effects of rediffusion of cathode rays upon X-ray structure, D. L. WEBSTER. H. CLARK, and W. W. HANSEN.

The heat of formation of water, F. D. ROSINI.

Diffusion of electrolytes and of colloids in aqueous solution, T. H. LIU and J. W. MCBAIN.

Titles and abstracts of all papers presented at this meeting are included in this report. G. H. W.

The Activities of Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania, U. S. A. E. R. WEIDLEIN. Reprint from *The Industrial Chemist*, 33 Tothill Street, London, S.W. 1., England. 12 pp.—The topics discussed are (1) the operating principles of the Institute's research procedure, (2) new industries created at the Institute, (3) researches on fuel economy, (4) textile research, (5) the Institute's fellowship system, (6) other activities. R. L. H.

Research on Fuel Economy at Mellon Institute. W. A. HAMOR. Reprint from *Combustion*, Oct., **1930.** R. L. H.

Preliminary Announcement, Indianapolis Meeting, A. C. S., March 30–April 2, 1931. See page 180.

Change of Rules in 1930–31 A. C. S. Prize Essay Contest. See page 181.

Regional Meeting of A. C. S. at Oberlin College. See page 181.

William Barton Rogers Honored at University of Virginia. See page 184.

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Staff Changes and Department Progress at The Ohio State University. See page 195.

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Ira Remsen Society of the School of Mines and Metallurgy, University of Missouri. See page 196.

Department Changes and Activities at the University of Virginia. See page 196.

Colloid Lectures at University of Wisconsin. See page 197.

Dr. Hale Lectures in Interest of American Chemistry. See page 197.

FOREIGN CHEMICAL AND EDUCATIONAL CONDITIONS

Education as a Means of Social Control in China. Y. K. CHU. *Educ. Outlook*, **4**, 193–9 (May, 1930).—A description and comparison of early education in China and the new movement since 1917. The relation of both forms of education to the respective contemporary social structures is indicated.

The new education in China is a result of social changes and is now being used consciously to direct and control the type of society which brought it into being.

The dominant ideas of the new China are embodied in the "Three Principles of the People": (1) "The Principle of People's Nationality," calling for an independent China. (2) "The Principle of People's Sovereignty," and meaning that the masses shall have political power; and (3) "The Principle of People's Livelihood," seeking a happy mean between capitalism and communism. S. R. P.

A State Experiment in Chemical Research. G. T. MORGAN. *Chem. & Ind.*, **49**, 739–48 (Sept. 5, 1930).—*Cf.* J. CHEM. EDUC., **7**, 3001 (Dec., 1930). E. R. W.

Research at Teddington, England. See **A State Experiment in Chemical Research immediately above.**

Junior College Journal. A new national educational periodical, the *Junior College Journal*, will begin publication in October, 1930. It will be published by Stanford University Press, and will be under the joint editorial control of the American Association of Junior Colleges and the School of Education of Stanford University. The new journal will appear monthly with the exception of the summer months.

Although there are more than four hundred junior colleges in the United States, with an enrolment of approximately sixty thousand students, there has been no periodical devoted especially to their interests. It is felt, therefore, that the new journal will fill a place not occupied by any other educational journal and should have an important influence in the unification and progress of the junior college movement in American education.

Dr. Walter C. Eells, of the Stanford University School of Education, will be editor-in-chief of the new periodical, with Doak S. Campbell, of Nashville, Tennessee, secretary of the American Association of Junior Colleges, as associate editor. A national editorial advisory board of twenty men will include the members of the executive committee of the American Association of Junior Colleges, and other men who are recognized as national leaders in the organization and development of the junior college movement.

Palladium Chemical Detects Deadly Gases. Warning of the presence in the air of carbon monoxide and other deadly gases such as hydrogen sulfide may now be given by a chemical in a handy little container similar in appearance to the first-aid ampules of aromatic ammonia. This carbon dioxide detector has been tested and found satisfactory by the Pittsburgh Experiment Station of the U. S. Bureau of Mines.

The little ampule may be carried by the workman going into garages, sewers, mines, or other places where the air might be contaminated. When the outer covering is crushed, a white filter paper or wad of white cotton soaked in palladium chloride is exposed to the air. Palladium chloride is a light straw color and does not discolor the white cotton, but as soon as it meets carbon monoxide or several other poisonous gases, the palladium is freed and the cotton turns gray or black, the intensity of the black depending upon the amount of the poisonous gas present.

Unfortunately for scientific purposes, palladium chloride does not distinguish between carbon monoxide and several other gases, but for practical purposes this does not matter in the least, since none of the gases is recommended for breathing purposes.—*Science Service*

Contemporary News in Chemistry and Education

PRELIMINARY ANNOUNCEMENT, INDIANAPOLIS MEETING, A. C. S., MARCH 30–APRIL 2, 1931

Program

The program of the Division of Chemical Education at the 81st meeting of the American Chemical Society will include a symposium on "Coöperation between Industry and Chemical Education," two half-day sessions for the reading of miscellaneous papers, a meeting of the Senate of Chemical Education, a meeting of the Editorial Board of the JOURNAL OF CHEMICAL EDUCATION and *The Chemistry Leaflet*, a business meeting, a luncheon March 31st, complimentary to all high-school teachers of chemistry in the Indianapolis area, and an all-day trip (April 2nd) to dedicate the new chemistry building at Indiana University.

Upon this last-named occasion, members of the Division will be the guests of Indiana University, and of the Limestone Association of the Bloomington Oolitic Limestone District. A complimentary luncheon will be served by the university, while the expense of the bus trip will be borne by the Limestone Association.

Exhibits

High-school chemistry classes everywhere are invited to send exhibits to the Indianapolis meeting. A prize of $10.00 is offered by the Division for the best one submitted. Free space will be reserved on request to the Local Secretary of the Division, but each exhibitor must assume all costs of packing, transportation, breakage, and loss.

Industries desiring to exhibit at the Indianapolis meeting should correspond with EDGAR B. CARTER, Swan-Myers Co., Indianapolis.

Papers

By vote of the Council of the A. C. S., papers by American chemists not members of the A. C. S. shall not appear on the program unless they be joint papers with society members, and no papers may be presented at a meeting unless the title has been printed on the final program. Papers for the symposium on "Coöperation between Industry and Chemical Education" will be by invitation.

Titles for papers designed to be read before the Division of Chemical Education should be sent as early as possible to the Secretary of the Division, while the *completed* paper together with two copies of an abstract must be received not later than March 1st. Manuscripts which reach the Secretary after this date will be held over, with the author's consent, for a subsequent meeting.

Papers read before the Division become the property of the society, and, if acceptable for publication, will appear later in the JOURNAL OF CHEMICAL EDUCATION.

Since the time available for each paper will be strictly limited, authors are earnestly requested to coöperate as follows:

1. Condense the material so that it may be presented in 5–8 minutes, leaving time for adequate critical discussion, which should be one of the chief functions of our program meetings. In general, not more than fifteen minutes, including discussion, will be allotted any one paper.
2. Organize significant features on slides, films, or in mimeographed form for distribution.
3. Do not send in a title unless you expect to be present to read your paper.

R. A. BAKER, *Secretary*,
College of the City of New York,
17 Lexington Avenue,
New York, N. Y.

JOHN R. KUEBLER, *Local Secretary*,
for the Indianapolis Meeting,
5503 E. Washington Street,
Indianapolis, Ind.

CHANGE OF RULES IN 1930–31 A. C. S. PRIZE ESSAY CONTEST

The Committee on Prize Essays of the A. C. S. has announced the following changes in the rules governing the 1930–31 contest.

Rule 3: From the hundreds of inquiries received by the committee seeking an interpretation of Rule 3 as it should be applied to the different conditions existing in the individual schools it is apparent that Rule 3 cannot be uniformly applied. *Therefore Rule 3 is herewith rescinded.*

Rule 11: The committee intends that every student-competitor shall receive guidance and supervision from his teacher in the preparation of his essay, whether the essay is a voluntary, independent effort, or a required part of the regular school work. The amount and manner of such guidance and supervision must, of course, be governed by the conditions in the particular school. Hence, the time, place, and method of preparing the essay are left to the judgment of the teacher. The committee is confident that the teacher will so coöperate in this matter that he can certify, as required by Rule 11, that the essay is the original work of the student and was written under his guidance and supervision.

Many inquiries have been received about typewriting the essays. The committee prefers that the essay as finally submitted shall be typewritten, if typewriting facilities are available. However, it is assumed that the student will handwrite the earlier drafts of his paper.

REGIONAL MEETING OF A. C. S. AT OBERLIN COLLEGE

One hundred and eighty members of the American Chemical Society assembled at Oberlin College on November 1st last for the seventh annual regional meeting of the sections of the society in Ohio and neighboring states. The coöperating and invited sections were: Akron, Cincinnati, Columbus, Cleveland, Detroit, Erie, Indiana, Louisville, Lexington, Midland, Pittsburgh, Purdue, Toledo, Kanawha Valley, Michigan State College, University of Michigan, and Ohio Northern University.

The meeting found the source of its inspiration in the historic environment in which it took place, the scenes of the labors of CHARLES M. HALL in his study and discovery of the process of making aluminum. It was at Oberlin College that Hall's enthusiastic researches developed with the encouragement of the late Professor Frank Fanning Jewett, and the visitors to the meeting had the privilege of seeing the first piece of aluminum ever made by the present commercial process and of visiting the house in which Hall completed his work.*

FRANK FANNING JEWETT

An exhibit of the newest developments in industry lent further interest to the occasion, showing as it did the tremendous recent growth of the use of aluminum decorative spandrels, shingles, grills, window frames, medallions, etc., in modern architecture. The exhibit of "Alclad" sheets consisting of strong aluminum alloys with thin layers of extraordinarily pure aluminum rolled on the outside lent additional weight to the masterly address of ZAY JEFFRIES, of the Cleveland branch of the Aluminum Company of America.

The complete program, which was arranged by a committee consisting of DR. HARRY N. HOLMES, chairman, DR. A. P. LOTHROP, and DR. W. H. CHAPIN, all of Oberlin College, follows:

9.30 a.m., Severance Laboratory

1. Remarks by ERNEST HATCH WILKINS, president of Oberlin College.

* See H. N. HOLMES, "The Story of Aluminum," J. CHEM. EDUC., 7, 233–44 (Feb., 1930).

GUESTS AT THE REGIONAL MEETING OF A. C. S. SECTIONS AT OBERLIN COLLEGE VISIT THE HALL HOUSE (UPPER) AND SEVERANCE LABORATORY (LOWER)

2. The Colloidal Chemistry Involved in Pulp and Paper Manufacture. HARRY F. LEWIS, director of the Institute of Paper Chemistry, Appleton, Wis.
3. The Nature and Measurement of Frictional Forces and Their Relation to Chemical Structure. E. KARRER, Goodrich Company, Akron, Ohio.
4. Cetyl-Sulfonic Acid as a Typical Electrolyte. J. W. MCBAIN, Stanford University, and ROBERT C. WILLIAMS, Firestone Tire & Rubber Company, Akron, Ohio.
5. The Use of Molds in Chemical Manufacture. HORACE T. HERRICK, U. S. Bureau of Chemistry and Soils, Washington, D. C.

Adjournment for Luncheon at Oberlin Inn at 12.30

2.00 p.m., Severance Laboratory

1. The Structure of Aluminum Alloys. ZAY JEFFRIES, Aluminum Company of America, Cleveland, Ohio.
2. The Manufacture of Beryllium. H. S. BOOTH, Western Reserve University, Cleveland, Ohio.
3. The Nature of the Highly Unsaturated Fatty Acids of the Brain. J. B. BROWN, The Ohio State University, Columbus, Ohio.
4. The Chemistry of Some Metabolic Errors in the Living Organism. H. B. LEWIS, University of Michigan, Ann Arbor, Mich.

Adjournment at 5.00 P.M. for Inspection of the Laboratory

Dinner, Oberlin Inn, 6.00 P.M.

7.30 p.m., Warner Hall

Half-hour concert by members of the faculty of the Oberlin Conservatory

J. HOWARD MATTHEWS, head of the chemistry department, University of Wisconsin, Madison, Wis. Address, Crime Detection by the Chemist.

. . .

The JOURNAL *acknowledges its indebtedness to Dr. H. N. Holmes, of Oberlin College, for the accompanying photographs.*

WILLIAM BARTON ROGERS HONORED AT UNIVERSITY OF VIRGINIA

WILLIAM BARTON ROGERS, founder of the Massachusetts Institute of Technology in 1859 and its first president for two consecutive periods 1865–1870 and 1878–1881, was honored on his 126th birthday on December 7th, by the dedication of a bronze tablet in the chemical laboratory at the University of Virginia, commemorating Dr. Rogers' association with this institution as professor of natural philosophy during the years 1835–1853. Natural philosophy in those days having included then known materials in physics, geology, hydraulics, chemistry, and astronomy, but perhaps more physics than any other one subject, it was appropriate that Rogers' identification with the University of Virginia should have been described by DR. L. G. HOXTON, senior physicist at the university and the second successor to Dr. Rogers in the chair of physics. The tablet was presented by the Virginia Section of the Alumni of M. I. T. through its president, MR. J. SCOTT PARRISH of Richmond, Va. DR. EDWIN ANDERSON ALDERMAN, president of the University of Virginia, accepted the tablet. DR. SAMUEL W. STRATTON, the president of the Massachusetts Institute of Technology, spoke on the services of Rogers in connection with that institution.

LIGHT COLOR CHANGE IS MOST IMPORTANT DISCOVERY OF RAMAN, HINDU NOBEL PRIZE WINNER

The discovery that light of a single color, or wave-length, shining on certain transparent substances, is partly changed to other colors is regarded as the greatest accomplishment so far of SIR CHANDRASEKHARA VENKATA RAMAN, Hindu scientist who has just been awarded the Nobel Prize in physics. Named after its discoverer, this phenomenon is now known as the Raman effect, and it was first announced in the spring of 1928. Research laboratories in all parts of the world are

now engaged in studying it, because it has opened up an entirely new field in the study of molecular structure.

Science Service Photo

One of the first scientists to verify it, outside of Sir Chandrasekhara's own laboratory, was DR. R. W. WOOD, of The Johns Hopkins University. Working at the private laboratory of ALFRED L. LOOMIS, Tuxedo Park, N. Y., Professor Wood considerably improved the original apparatus of the Indian scientist and detected the effect in the summer of 1928.

The Raman effect occurs when monochromatic light (which is light of a single color or wave-length) shines on transparent substances, such as quartz, chloroform, or water. Generally a mercury arc is used as the light source. The light that is scattered by the transparent material is mostly of the same color as that of the light illuminating it. The spectroscope, the instrument that analyzes light, however, shows that part of this light is changed to wave-lengths a little longer or shorter than that of the source. That is, part of the light is either more reddish or more bluish.

On the spectrum photographs, the result is a heavy line, representing the main color, attended on either side by narrower and fainter lines. The fainter lines on one side are arranged the same way as those on the other, except that they are reversed, as if reflected in a mirror, the center heavy line being the mirror. Sir Chandrasekhara, in his first experiments, found only a single and very faint line on the high frequency, or blue, side of the main one; but with the improved apparatus Professor Wood found groups of nearly equal strength on each side.

The great importance of the discovery came from the fact that the differences between the frequency of the exciting color, used to illuminate the substance, and the frequency of the additional, or Raman, lines is precisely the same as the frequencies of the infra-red absorption bands of the same substance. These absorption bands, that is, the bands of color absorbed by the substance with infra-red light, or light vibrating too slowly to be seen, are very difficult to determine directly, so the Raman effect was a very convenient means of studying them. Thus it gave a new means of studying the properties of the molecules of these substances, and of the structure of light.

Incidentally, it was a rather convincing proof of the validity of the quantum theory of light, which supposes that light, and other radiations, consists of separate pulses, or quanta, rather than waves. Five years before the effect was discovered, it had been predicted, on the basis of this theory, so when it was detected it immediately provided good evidence in favor of the existence of light quanta.

Sir Chandrasekhara was born in India on November 7, 1888, and graduated from the Presidency College in Madras in 1904. In 1907 he joined the Indian Finance Department, and after that held various scientific positions, finally becoming Sir Taraknath Palit professor of physics at Calcutta University and honorary professor at Benares Hindu University. In 1924 he visited the United States, following the meeting of the British Association for the Advancement of Science at Toronto, to attend the centenary celebration of the Franklin Institute in Philadelphia. After that he served for a time as research associate at the California Institute of Technology at Pasadena. In the same year he was made a fellow of the Royal Society, the highest British scientific body. He was knighted in 1929.—*Science Service*

HANS FISCHER WINS NOBEL PRIZE AWARD IN CHEMISTRY

The award of the 1930 Nobel Prize in chemistry to PROFESSOR HANS FISCHER of Munich, Germany, for his research on human blood is a recognition of the value of what is sometimes called pure science, meaning discoveries or developments which are of great theoretical importance but which may or may not have practical value.

Professor Fischer's recent noteworthy contribution was the synthesis, or laboratory production, of hemin, which is one of the components of hemoglobin, the red coloring matter of the blood.

Hemin has also been called the respiration ferment, said to rule the organic world. In the higher animals, hemoglobin is a transport agency for oxygen, carrying it from one place to another in the body, but the respiration ferment, hemin, takes up the atmospheric oxygen, which was transported by the hemoglobin, and transfers it to certain organic substances which in turn become oxidized. The respiration ferment or enzyme rules the organic world because in everything that happens in living matter, respiration furnishes the driving force. It is found in all living cells.

Professor Fischer's synthesis of hemin made possible the artificial production of hemoglobin itself, which is indispensable for the life of animals, especially mammals.

When Professor Fischer announced this synthesis last year, scientists hailed it as an important contribution to the chemistry of living matter. Some claims were made for it on practical grounds, but Professor Fischer himself did not agree with these views.

"Contrary to many fantastic statements of the daily press no changes will take place in the field of therapeutics," he said, "since hemin has been easily obtainable from blood for a long time. It is improbable that the intermediate products of the syntheses and the numerous isomeric hemins, on which work is being done, will gain a practical importance, but their investigation is of interest from a theoretical viewpoint. In addition, the influencing of the metabolism of the blood pigment in this way is not probable since this probably depends upon sterins or substances closely related to them."

Professor Fischer was born at Hoechst-Am-Main in 1881. He studied at the University of Lausanne, at Marburg, where he received the degree of doctor of philosophy, and at Munich, where he was made a doctor of medicine. He has been on the faculties of various German universities and is now head of the Organic-Chemical Institute of the Munich Technical High School. He has devoted himself to studying the pigments of blood and bile and pyrrol chemistry.—*Science Service.*

MONEY TO AID RESEARCH OFFERED AMERICAN SCIENTISTS

To aid in research projects that would otherwise be handicapped by lack of equipment, the American Association for the Advancement of Science will dis-

tribute a total of about $3000 in grants of $50 to $500.

Recipients of the grants are expected to make a report of the progress of their investigation within a year after the funds are given. The committee consists of DR. WALTER S. ADAMS, astronomy; DR. CHARLES P. BERKEY, geology; PROF. ARTHUR H. COMPTON, physics; DR. KARL F. KELLERMAN, botany; PROF. W. LASH MILLER, chemistry; PROF. GEORGE H. PARKER, zoölogy; PROF. OSWALD VEBLEN, mathematics, and DR. WILLIAM C. WHITE, medicine.—*Science Service.*

EDUCATIONAL REORGANIZATION AT THE GEORGE WASHINGTON UNIVERSITY

A new departure in administration was inaugurated with the opening of the one hundred and tenth academic year of the George Washington University, when the institution adopted the educational organization which recently was effected for the purposes of overcoming standardization, accomplishing a return to the "master-fellow" relationship between teacher and student and restoring the democracy and community spirit which characterized earlier faculties. While not entirely new in its individual principles, the George Washington University plan is a distinct educational advance in their association in a comprehensive scheme.

Freshman and sophomore students of the university, both pre-professional and those preparing for entrance to Columbian College, the senior college of letters and sciences, will be registered in the university's newly established junior college, where their first two years of college work will be closely supervised by a corps of trained advisers. At the end of the sophomore year students will receive junior-college certificates, terminating their college careers at a logical point if they cannot or do not desire to continue; or certifying them to the senior college or the professional school of their choice.

In the senior college special provision for the discovery and development of creative ability in the individual student has been made through the adoption of a plan for independent study. Under this plan a student of demonstrated capacity with special interest in a course may be permitted to undertake independent study under the personal direction of the instructor and freed from formal class requirements. The master's degree, viewed as the rounding out of the cultural education, will be administered by the senior college, and it is expected that students, in the normal course of events, will take this additional year of study.

The degree of doctor of philosophy will be administered by a council for graduate study, as a professional and purely research degree. The resources of the city of Washington in trained personnel for the direction of scholarly research and in source materials will be made available for a carefully selected group of mature students.

Educational control will rest entirely with the faculty, operating through divisions of study, while personnel administration will fall to the dean. Freed from administrative strictures and placed in sympathetic relationship to colleagues, the faculty member will be encouraged to do stronger and more creative work.

Four divisions of study have been created—languages and literatures, mathematics and the physical sciences, the natural sciences and the social sciences. The grouping of curriculum departments under these divisions is based upon such factors as the relationship of content, the interrelation of methods and of prerequisites, and similarity of background and viewpoint.

In commenting upon the new organization, DR. CLOYD HECK MARVIN, president of the university, points out that the plan will succeed only in so far as the instructional staff remembers that the teacher's province is so to order the university environment that the student will be inspired to train himself, to be enthusiastic in the use of his mind and to be fearless in

the pursuit of knowledge. The freedom and companionship gained under the new plan provide opportunity for the stimulation of scholarly personality through the impact of character.—*School and Society.*

THE ALL-UNIVERSITY CURRICULUM OF THE UNIVERSITY OF MINNESOTA

Appointment by PRESIDENT L. D. COFFMAN of a general committee to supervise the new all-university curriculum sets in motion a plan under which students selected by that committee may break through the bars between colleges and study the things they want, wherever they find them.

This plan, worked out during the past year by a committee named by the president, was approved by the board of regents on June 28th. Mistakenly described at that time as "an experimental college," it is instead an experiment in student independence. On the campus it is said to be viewed as an important step away from over-organization and a breaking of red tape.

The gist of the resolution approving the new idea is a sentence which empowers the committee "to approve modifications of or substitutions in individual students' curricula with the provision that the modifications or substitutions thus authorized shall be accepted for credit toward degrees."

This makes the committee an instrument for clearing the track in the interests of the ablest students and a court of appeals in cases where college restrictions seem to be working a hardship.

On the general committee to supervise the new plan the chairman will be PROFESSOR JOHN T. TATE of the department of physics. With him will be DEAN GUY S. FORD of the graduate school; J. C. LAWRENCE, assistant to the president; HERBERT HEATON, extension division; MALCOLM M. WILLEY, sociology; ROSS A. GORTNER, biochemistry; CLARA M. BROWN, home economics; CHARLES W. BOARDMAN, university high school; FRED ENGELHARDT, educational administration; WILLIAM H. KIRCHNER, drawing and descriptive geometry; JOHN H. KUHLMANN, electrical design; CHARLES A. MANN, chemical engineering; LLOYD H. REYERSON, chemistry; J. CHARNLEY MCKINLEY, medicine; E. T. BELL, bacteriology; KATHERINE J. DENSFORD, nursing; HAROLD F. WAHLQUIST, dentistry; CARL W. WALDRON, dentistry; RALPH L. DOWDELL, mines; RALPH H. DWAN, law; WALTER R. MYERS, business; WILLIAM H. STEAD, business.—*School and Society.*

FELLOWSHIPS AND SCHOLARSHIPS FOR STUDY IN FOREIGN COUNTRIES OPEN TO AMERICAN STUDENTS

Announcement by Institute of International Education

A limited number of foreign study fellowships are offered under the international student exchanges of the Institute of International Education to American students who wish to study abroad. These fellowships have been established as an international exchange in appreciation of those offered by American colleges to the nationals of the countries concerned.

General Requirements for Eligibility

A candidate applying for one of these fellowships must

(1) Be a citizen of the United States or of one of its possessions;
(2) At the time of making the application be a graduate of a college, university, or professional school of recognized standing, or a senior who will have met this requirement before entering upon the fellowship;
(3) Be of good moral character and intellectual ability, and of suitable personal qualities;
(4) Present a certificate of good health;
(5) Possess ability to do independent study and research; and
(6) Have a practical reading, writing, and speaking knowledge of the language of instruction in the particular country.

These opportunities are open both to men and to women. Preference in selection is given to candidates under thirty years of age.

Scholarship and fellowship holders must have sufficient money of their own to cover traveling, vacation, and incidental expenses. French steamship lines allow a reduction in steamship rates to French fellowship holders. In some instances free visas may be secured.

For Study in Austria

Several fellowships covering board, lodging, and tuition (a few providing for, free tuition only) are offered through the Austro-American Student Exchange. These fellowships are available for study at the institutions of higher learning in Austria.

Applications must be submitted on or before February 1st.

For Study in Czechoslovakia

The Czechoslovak Ministry of Education offers, through the American Czechoslovak Student Exchange, several fellowships of 15,000 Czechoslovak crowns each (equivalent to about $500 which approximately covers room, board, and tuition). These fellowships are available for study at The Charles University, the University of Technological Sciences, the Arts Academy and the Commercial College in Prague, at the Masaryk University and the Institute of Technology in Brno and at the Komensky University in Bratislava.

Applications must be submitted on or before February 1st.

For Study in France

The Ministry of Public Instruction and the universities of France offer, through the Franco-American Student Exchange, a number of fellowships covering board, lodging, and tuition and some providing free tuition only. These fellowships are available for men or women at the Universities of Grenoble, Lyon, Strasbourg, and Toulouse. The fellowships at Bordeaux and at the École Supérieure de la Metallurgie et de l'Industrie des Mines at Nancy are designated for men. The École Normale Supérieure de Sévres is for women and the one full fellowship at the University of Paris is available for a woman only.

Applications must be submitted on or before February 1st.

For Study in Germany

The German universities, through the *Akademischer Austauschdienst*, the representative in Germany of the American-German Student Exchange, have established a number of fellowships covering board, lodging, and tuition. These fellowships are available for study at the Universities of Berlin, Bonn, Breslau, Frankfurt, Freiburg, Göttingen, Halle, Hamburg, Heidelberg, Kiel, Köln, Leipzig, Marburg, Munich, Münster, Tübingen and Würzburg, and at the technological institutes at Danzig and Munich.

Applications must be submitted on or before January 15th.

For Study in Hungary

The Hungarian Ministry of Education offers, through the American-Hungarian Student Exchange, several fellowships covering lunch and dinner at one of the students' messes, lodging, and tuition. These fellowships are available at the University of Budapest, the Technical University of Budapest, the University Faculty of Economic Sciences, the Veterinary College, and the Music Academy, all in Budapest.

Applications must be submitted on or before February 1st.

For Study in Italy

The Italian government offers, through the American-Italian Student Exchange, five fellowships covering board, lodging, and tuition. These fellowships are available for study at the institutions of higher learning in Italy. Applications must be submitted on or before February 1st.

For Study in Spain

The Spanish government, through the *Junta para Ampliación de Estudios* and

the *Ciudad Universitaria*, offer several graduate fellowships, covering fees, board, and lodging. These fellowships are available for study either at the University of Madrid or the *Centro de Estudios Historicos*. Since these fellowships are on a direct exchange basis, a candidate should ascertain from the institution from which he graduates whether that institution has entered into the exchange agreement.

For Study in Switzerland

The universities of Switzerland offer, through the Swiss-American Student Exchange, a number of tuition scholarships. In several instances these scholarships are supplemented by stipends covering board and lodging, or their equivalent, provided in the communities in which the universities are located. These scholarships are available at the Universities of Basle, Berne, Fribourg, Geneva, Lausanne, Neuchatel, and Zürich and at the *Eidgenossiche Technische Hochschule* in Zürich and the *Handelshochschule* in St. Gallen.

Additional Opportunities

In addition to the fellowships already described, the Institute of International Education administers the American Field Service Fellowships for advanced study in French universities, Germanistic Society of America Fellowship for study at a German university, and the Scholarships for the Junior Year Abroad. The Institute also arranges for the placement of a number of American men in *postes d'assistant d'Anglais* in French *lycées* and *écoles normales*.

Application blanks and further information concerning all these opportunities may be obtained from The Student Bureau, Institute of International Education, 2 West 45th Street, New York, N. Y.

THE ELECTROCHEMICAL SOCIETY WESTON FELLOWSHIP IN ELECTROCHEMISTRY

This fellowship ($1000) is open to candidates who have completed an undergraduate course in some college, university, or technical institution, and have received a degree of such institution. The candidates must possess marked capacity in carrying out research in electrochemistry.

The candidate must be under the age of thirty years at the time of the award of the fellowship. The award will be made without distinction on account of sex, citizenship, race, or residence. The award will be made for a term of one year, but the board of directors shall have the option in its discretion of continuing the award to the same fellow.

Applications for the fellowship for the academic year October 1, 1931, to June 1, 1932, must be received by the secretary of the society before March 1, 1931. Application forms are obtainable from the secretary.

The successful candidate may carry out research in electrochemistry at any institution of learning approved of by the board of directors of the society.

For further details apply to COLIN G. FINK, secretary, The Electrochemical Society, Columbia University, New York City.

GUGGENHEIM FELLOWSHIPS FOR LATIN AMERICA

The Guggenheim Foundation fellowships have been made available by the trustees for students of Argentina and Chile. Citizens of Mexico have already been admitted and Cuba and other Latin-American countries will be added to the list later.

Five fellowships have been awarded to students from Argentina and seven to students from Chile. The arrangements for awarding fellowships in these two countries were made by DR. FRANK AYDELOTTE, president of Swarthmore College and chairman of the foundation's advisory board, and by DR. EYLER N. SIMPSON, the foundation's representative in Mexico.

These fellowships usually provide a stipend of $2500 for one year, with a

possibility of renewal and a travel allowance.—*School and Society.*

INTERNATIONAL INSTITUTE OF INTELLECTUAL COÖPERATION

Nature reports that the sphere of work of the League of Nations' Committee on Intellectual Coöperation has recently formed the subject of a general inquiry by a committee specially constituted for the purpose at Geneva. In the light of this committee's report, a number of proposals have been submitted to and approved by the Assembly of the League with the object of defining a program and improving work in this field. Among the changes thus brought about is the constitution of committees of experts which will replace the formerly existing subcommittees of the League's International Committee on Intellectual Coöperation. An inquiry is to be initiated forthwith into the intellectual life of our time with special reference to methods of education at all stages in the different countries. The attention of governments is being directed to the utility of the work done by the bureaus responsible in the different countries for international interchanges of publications, with the suggestion that they should be placed in a position to act as liaison between learned societies for exchanges of their publications and should accordingly be provided with the necessary funds. The work of the International Educational Cinematographic Institute, including the publication in five languages of the International Review of Educational Cinematography, is highly appreciated by the Assembly of the League; and governments are being asked to give their sympathetic consideration to the draft convention, prepared and circulated by the Institute, for the abolition of customs barriers which interfere with the distribution of educational films, and generally to lend their aid and support to the Institute.

Nature also reports that the National Central Library and several other British libraries are taking part in an extensive correlation scheme inaugurated by the International Institute of Intellectual Cooperation of the League of Nations. For several years this body has been endeavoring to collect information regarding the national and central libraries of different countries, with the view of creating a liaison between existing services. This was accomplished at the end of 1928, when a coördinating service of libraries was established by the International Institute. In order to increase the value of the coordination, at the request of an international congress of librarians held in 1929, there has just been issued a "*Guide des services nationaux de renseignements du prêt et des échanges internationaux*" (Paris: *Institut Internationale de Coopération Intellectuelle*, 1930). In this appear concise notices of the centers of bibliographical information in every country where they exist or are in process of organization, and in addition the addresses are given of all the bureaus for the international exchange of publications. Fifty-five nations or States are represented in the lists, an indication of the possibilities of this newly founded international service.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The fourth Cleveland meeting of the American Association for the Advancement of Science was held during the week of December 29, 1930. DR. ROBERT A. MILLIKAN gave on the evening of the opening day the retiring presidential address. The Sigma Xi lecture on December 30th was given by DR. C. E. K. MEES.

MONTANA SECTION, A. C. S.

The meeting of the Montana Section of the A. C. S. in Butte on November 6th was the first the Montana Section has conducted in a city other than Bozeman, where its chartered headquarters are located. This meeting will, in all probability, be the first of such meetings to be held in the fall and spring of each year. The chemists of Montana have hopes that

these meetings will become an established institution and that they will have a far-reaching and beneficent effect upon the inter-relationships of the chemical industries and of chemical education in the state. In addition, this institution will, it is hoped, do much to disseminate appropriate chemical information and encourage the acquisition of chemical knowledge by direct experimentation and by the discussion of past and present-day findings.

The meeting occurred largely as the results of the efforts of the chemists of Butte, Anaconda, and Bozeman and was held in Butte under the auspices of the State School of Mines of the University of Montana. DRS. A. E. KOENIG, head of the department of chemistry of the School of Mines, and C. L. WILSON, professor of metallography, School of Mines, collaborated with DR. O. E. SHEPPARD, chairman of the section, to make the meeting a success.

Two papers were read after the business of the meeting had been transacted. R. C. STANAWAY, chemist, Anaconda Copper Mining Co., presented "Analytical Methods in the Phosphate Plant" and M. R. HOYT, superintendent of the acid plant, Anaconda Copper Mining Co., presented "The Manufacture of Nitric and Sulfuric Acids." A discussion followed each paper.

Preceding the meeting the Bozeman delegation were the guests of the State School of Mines and were shown the physical and chemical equipment of the institution. Later, about 6.30 P.M., all of the chemists met at Gamer's Café to banquet and to become acquainted. At this function, DR. F. A. THOMPSON, president of the School of Mines, extended greetings. Other men who spoke at this occasion and aided in making this event outstanding in enthusiasm were DRS. KOENIG, SHEPPARD, and R. E. KIRK.

DR. McPHERSON VISITS LOCAL SECTIONS, A. C. S.

Science has announced the recent lecture tour of DR. WILLIAM MCPHERSON, president of the A. C. S., in the course of which he visited twenty-two local sections of the society. These included Kentucky, Indiana, Illinois, Missouri, Kansas, Oklahoma, Texas, Louisiana, Alabama, Florida, Georgia, Tennessee, North Carolina, Virginia, and West Virginia. His lectures covered "Methods of Nature," "Reminiscences of Great Teachers of Chemistry," and "Chemistry of Organic Compounds of Titanium." The tour extended from October 27th to December 5th and was arranged by the local section officers committee, of which DR. ELLICE MCDONALD is secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Plans for a new building with unusual provisions for fundamental research and advanced instruction in physics and chemistry at the Massachusetts Institute of Technology have been announced by DR. KARL T. COMPTON, president of the institution.

Funds for starting the building, which will join two wings of the present buildings on the east side of the main Technology educational group, are available from the gift of $2,500,000 donated by Mr. George Eastman in 1916, as a supplementary fund for additional educational buildings when needed.

The new structure will be over 300 feet long, 60 feet wide, and will contain four stories, plus basement. It will include a well-equipped shop for the construction and maintenance of the delicate instruments used in research; a spacious lecture room, and a joint library and reading room for the use of the staff and students in physics and chemistry. The research rooms have been designed to permit the greatest flexibility in arrangements for future requirements. The construction specifications call for a structure of unusual rigidity with foundations of heavy reinforced concrete to aid in eliminating vibration, a necessary requirement because of the exacting standards of research in this field.

The importance of spectroscopy in the study of atomic and molecular structure which in the next decade seems certain to become the most important agency in chemical research, is recognized in plans for an additional separate spectroscopic laboratory to be housed in a building which will occupy a site in the quadrangle formed by the new physics building. The construction of the spectroscopic laboratory presents features which have called for engineering rather than architectural design. The two floors of this laboratory will be supported on a foundation of unique design which will be entirely separate from that of the outer walls and the roof of the building. This foundation is to be more than three feet thick, and composed of alternate layers of sand, felt, transite board, ground cork, and reinforced concrete. These elaborate precautions are expected to entirely eliminate shocks and vibration from industrial processes in the neighborhood and the movement of traffic on adjacent highways.

The spectroscopic laboratory will be 100 feet long and 60 feet wide, and in addition to the extraordinary precautions to eliminate vibration, provisions will be made for maintaining extreme constancy of temperature. The equipment of the laboratory includes a collection of the finest instruments which have been gathered at Leland Stanford University by PROFESSOR GEORGE R. HARRISON, who this year joined the staff of the Massachusetts Institute of Technology as director of the research laboratory of experimental physics.

In addition to the proposed physics and chemistry building, plans for a cryogenic laboratory for fundamental studies in the science of low temperatures are under consideration. These plans provide for a laboratory with the most advanced facilities for this type of research, with plants for the production of liquid nitrogen, hydrogen, and helium. Such a laboratory will place the institution in a unique position in America for carrying on important physical and chemical investigations.

NEW SCIENCE BUILDING AT UNIVERSITY OF NEVADA

It has been announced in *Science* that CLARENCE H. MACKAY, president of the Postal Telegraph Company, dedicated and laid the cornerstone of the new Mackay Science School building at the University of Nevada on October 24th for which Mr. Mackay gave the university $415,000. This brings the total gifts of the Mackay family to this institution to more than one and a half million dollars. JUDGE GEORGE S. BROWN, president of the Board of Regents, accepted the gift.

JACKLING, UTAH COPPER DEVELOPER, WINS MINING HONOR

Because by his development of Utah's low-grade copper ore on a large scale and because he solved a critical powder shortage during the World War, DANIEL C. JACKLING, president of the Utah Copper Company, has been selected to receive the 1930 William Lawrence Saunders Gold Medal by the American Institute of Mining and Metallurgical Engineers on October 31st, it is announced by *Science Service*. This medal is the annual recognition of notable achievement in mining and metallurgical engineering in the United States.

The rise to fame of this year's recipient is one of the romances of the country's mining industry. Thirty-six years ago, young Jackling, a Missouri farmer's son who had worked his way through the Missouri School of Mines, arrived at Cripple Creek, Colorado, with three dollars in his pocket. He had walked all the way from Colorado Springs, more than 25 miles, because he was unable to pay the stage fare. Today he is regarded as one of the leading figures in the mining world.

Mining authorities credit Mr. Jackling as having been the first to see in the low-grade copper ores of Utah a great source of mineral wealth. These low-grade ores

had been known for years but the methods of mining of earlier days were such that the Utah field was spurned by prospectors. Jackling foresaw that a large body of low-grade ore could be exploited profitably if large scale operation and improved machinery were used.

EINSTEIN IN THE UNITED STATES

PROFESSOR ALBERT EINSTEIN, accompanied by DR. WALTER MAYER, of the University of Vienna, as scientific assistant, arrived recently in this country to undertake special research work at the California Institute of Technology and the Mount Wilson Observatory. He will leave this country again in February, returning by way of New York, to fill a lecture engagement at Oxford.

THE DOW CHEMICAL COMPANY

WILLARD DOW, son of the late DR. HERBERT H. DOW, was recently elected by the board of directors of the Dow Chemical Company to succeed his father in the presidency of the company. The new executive, although but 33 years old, has had a wealth of experience in every phase of the company's activities and has served for the past few years as its assistant general manager and assistant treasurer.

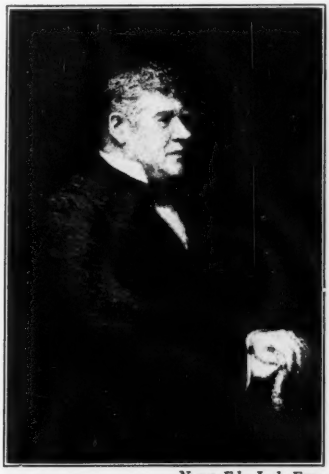
DR. BOGERT REAPPOINTED BY DEPARTMENT OF AGRICULTURE AND NATIONAL RESEARCH COUNCIL

PROFESSOR MARSTON T. BOGERT, of Columbia University, has been reappointed chairman of the Advisory Committee to the Color and Farm Waste Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

He has also been reappointed by the National Research Council as a member of the Central Petroleum Committee, by whom the $500,000 fund supplied by MR. JOHN D. ROCKEFELLER, JR., and the Universal Oil Products Company is being allocated for research work, and under whom this work is being carried out.

ELLWOOD HENDRICK

ELLWOOD HENDRICK, curator of the Chandler Chemical Museum of Columbia University, died on October 29th last at his home in New York, in his 69th year. The following résumé of his career is quoted from *Chemical and Metallurgical Engineering:* Born in Albany in 1861, he went abroad to receive his education at the University of Zurich and returned to his native city to become manager of a chemical works there for four years. For some twenty years afterward, however, he devoted himself to business and stock brokerage in New York before he returned to his early interest, chemistry, in the establishment of Arthur D. Little, Inc., at Cambridge, Massachusetts. His talent for educational writing was fostered there and meanwhile it further expressed itself in the form of several of his published books. . . .In 1924 he was appointed curator of the Chandler Museum. Recognition of his gifted personality came to



News Ed., Ind. Eng. Chem.

REPRODUCTION OF PORTRAIT OF ELLWOOD HENDRICK BY AUGUSTUS VINCENT TACK IN THE DUNCAN PHILLIPS COLLECTION, WASHINGTON, D. C.

him repeatedly from different societies as well as in the hearty reception of his books, among which the best known are: "Everyman's Chemistry," 1917; "Percolator Papers," 1919; and "Modern Views of Physical Science," 1925.

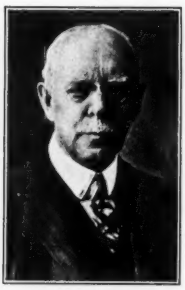
An editorial in a recent issue of the *New York Times* remarks of Hendrick: "He once said, after speaking of Tyndall and Huxley and Duncan, that there was no one left who had the mastery of the art to write of science. If there were and are others, their number is now less by one."

DEATH OF LORD BROTHERTON

Science has announced the death of Lord Brotherton, first baron of Wakefield, England, the founder of extensive chemical manufacturing plants throughout England and Scotland. Lord Brotherton was awarded in June of last year the Messel Medal by the Society of Chemical Industry [*see* J. CHEM. EDUC., **7**, 2523–4 (October, 1930)].

PERKIN MEDAL

The American Section of the Society of Chemical Industry on January 9th awarded the Perkin Medal for 1931 to ARTHUR D. LITTLE, president of Arthur D. Little, Inc., Cambridge, Massachusetts. This medal is awarded on a basis of lifetime achievement by a committee composed of representatives of five leading chemical societies.



SCHEELE MEDAL

Science announces that DR. OTTO FOLIN, professor of biochemistry at Harvard University, has been named as the first recipient of the Scheele Medal, awarded him by the Chemical Society of Stockholm. Award of the medal was announced in connection with the dedication of the Institute for Biochemistry building in Stockholm.

DEPARTMENT CHANGES AT MIDDLEBURY COLLEGE

PROFESSOR CONANT VOTER, of Middlebury College, sailed from Quebec, in September, for Europe, with his family. He will spend the winter in Southern France and Italy, and in the spring will tour through Germany, France, Holland, and England, visiting the laboratories of noted chemists and physicists. His sabbatical leave is made possible through the Walker Furlough Foundation of Middlebury College.

For the year 1930–1931, two new professors have been added to the staff of the department of chemistry at Middlebury. PROFESSOR J. S. THOMAS is in charge of the general and quantitative courses, and PROFESSOR E. B. WOMACK is in charge of the introductory and advanced organic courses. In Professor Voter's absence PROFESSOR J. F. HALLER is acting chairman of the department.

Research has been started on the chemistry of the hormones and the photochemistry of the keto-acids.

DEPARTMENT NEWS OF THE TULANE UNIVERSITY OF LOUISIANA

DR. RAYMOND FREAS has been appointed associate professor of chemistry, teaching organic chemistry, to succeed DR. S. A. MAHOOD, who now holds the Squibb's Fellowship at Yale. Dr. Freas has been associate professor of chemistry for the past eight years at Louisiana State University and was formerly on the Tulane faculty. Professor Freas holds the Ph.D. from Johns Hopkins University and was for several years engaged in research work in the chemical warfare service and at Edgewood Arsenal. MR. RAOUL J. LANDRY, M.Sc., has been appointed full-time instructor in chemistry to succeed MR. J. C. SIMMS. Mr. Landry was for

the past two years instructor in chemistry at Southwestern. He received the master's degree from Tulane in 1928.

In the report of DR. MILLS of the National Research Council, "Chemical Progress in the South," Tulane University and the Howard Memorial Library at New Orleans have been designated as one of the five centers of technical information in the South.

New equipment for research work in electro-organic chemistry has been installed and work in this field has begun.

STAFF CHANGES AND DEPARTMENT PROGRESS AT THE OHIO STATE UNIVERSITY

The following are promotions in and additions to the junior staff in the department of chemistry: S. F. WHIRL (A.B., Ohio State); J. L. QUINN (A.M., Boston Coll.); F. M. RICKERT (A.B., Bluffton Coll.); P. J. FLORY (A.B., Manchester Coll.); L. W. GEORGES (A.B., Notre Dame Univ.); C. S. SMUCKER (A.B., Bluffton Coll.); R. L. MCCLEARY (A.B., Ohio Northern Univ.).

MR. H. S. OLSON (Ohio State) is a graduate assistant in the department of metallurgy.

The following have been made assistants in the department of chemical engineering: O. H. THOMPSON (B.Ch.E., Ohio State); R. A. FISHER (M.Sc., Ohio State); T. G. DIXSON (B.Ch.E., Ohio State). For several years Mr. Thompson has been in the employ of the B. F. Goodrich Co. Mr. Fisher has been chemical engineer of the Westinghouse Co., East Pittsburgh, for the past six years.

MISS JANET SCOTT (A.M., Northwestern Univ.) recently became a member of the staff of *Chemical Abstracts* of the A. C. S.

MR. A. W. BOSWORTH of Roxbury, Massachusetts, is a research fellow in the department of physiological chemistry, where he is carrying on researches on the proteins of milk.

MR. HENRY HOLTZ is the present recipient of the N. W. Lord Fellowship in metallurgy, and is doing his investigational work in the department of metallurgy.

MR. KERMIT GROVES is a junior research assistant in the Engineering Experimental Station and is conducting a research involving a study of foaming and priming under the direction of PROFESSOR C. W. FOULK in the department of chemistry. Professor Foulk was also granted a sum of money by the graduate council to be used in studying certain other phases of the above problem.

The graduate council has made grants to the following members of the chemical faculty for investigational purposes: PROFESSOR J. B. BROWN, for a study of the chemical composition of the brain; to PROFESSOR W. L. EVANS, for work in the field of carbohydrates; to PROFESSOR W. G. FRANCE, for researches on the stability of sols; to PROFESSOR W. R. BRODE for continuation of his work on absorption spectra.

DEPARTMENT CHANGES AT THE UNIVERSITY OF CHICAGO

M. O. FOREMAN (Ph.D., 1929), and MR. R. W. JOHNSON have received appointments in organic research in the department of chemistry.

STANLEY D. WILSON (Ph.D., 1916), professor and head of the department of chemistry and dean of the college of natural sciences at Yenching University, Peking, China, is a guest of the university for the academic year 1930–31. Professor Wilson has returned for advanced study and research in the department.

W. H. ZACHARISEN, of the University of Oslo, Norway, has been appointed an assistant professor in the department of physics.

UNIVERSITY OF BUFFALO

An Intersectional Meeting of the Schenectady, Syracuse, Rochester, Cornell, and Western New York Sections opened on Friday morning, November 28, 1930, at Hotel Statler. The morning sessions were held at the hotel; the afternoon

sessions were held at the Buffalo Museum of Natural Science. At dinner in the evening DR. JOSEPH C. W. FRAZER, of Johns Hopkins University, spoke on the subject of "Catalysis" and included in his address a survey of the last few years' work in that field, as well as a few words on the catalytic oxidation of carbon monoxide.

On Saturday morning the meetings were held at Foster Hall on the campus. The morning sessions were devoted to addresses by PROFESSOR G. HEVESY, visiting professor at Cornell University, who spoke on the subject, "The Chemistry and Geochemistry of the Titanium Group" and DR. W. L. MILLER of the University of Toronto. After DR. MILLER'S address symposia were held on biochemistry and the dyeing of rayon.

At noon the officers of the intersectional meeting and those of the Western New York Section were tendered a luncheon by The University of Buffalo at the Saturn Club. The afternoon industrial trips were taken to the plants at Niagara Falls.

The alumni of Alpha Chi Sigma fraternity held their initiation and banquet, Saturday afternoon and evening, under the auspices of Pi chapter, of Syracuse University.

UNIVERSITY OF FLORIDA

The twenty-seventh meeting of the Florida Section, A. C. S., was held in the chemistry-pharmacy building of the University of Florida on Saturday evening, October 25th. The meeting was devoted to a symposium on chemical education and the following program was presented: "The Teaching of Chemistry in the High Schools," PROF. J. M. PEARCE, Hillsborough High School, Tampa, Fla.; "High-School Preparation for College Chemistry," DR. F. H. HEATH, professor of chemistry, University of Florida; "The JOURNAL OF CHEMICAL EDUCATION," PROF. A. P. BLACK, department of chemistry, University of Florida; "The Cincinnati Meeting of the A. C. S.," Individual reports from: DR. TOWNES R. LEIGH, head, department of chemistry, University of Florida; DR. V. T. JACKSON, professor of chemistry, University of Florida; DR. JOHN CONN, head, department of chemistry, Stetson University, DeLand, Fla.

IRA REMSEN SOCIETY OF THE SCHOOL OF MINES AND METALLURGY, UNIVERSITY OF MISSOURI

DR. J. H. GARDNER, professor of organic chemistry at Washington University, addressed the Ira Remsen Society of the School of Mines and Metallurgy, University of Missouri, on November 5th on the subject, "Coal and Petroleum as a Chemical Raw Material." A few years ago coal was not considered as anything but a fuel, and was used without any thought of conservation. The organic chemist, through his researches, has brought the derivatives of coal to the market and they are of far greater importance than coal used alone as a fuel. The advancement in the researches along this line have been much greater in the last fifteen years than all advancement before that time. From all indications, the advancement in the next five or ten years will be far greater than in the last fifteen years, Dr. Gardner said.

On November 19th DR. L. F. YNTEMA, formerly with the University of Illinois, but now head of the chemistry department at St. Louis University, addressed the Ira Remsen Society on "Ammonia and Some of Its Derivatives." He told of the electrodeposition of metals from liquid ammonia, and because ammonia is not a convenient thing to work with, he also discussed results obtained by various substitutes such as formamide and acetamide. Following his talk he gave demonstrations of the electrodeposition of nickel and cadmium.

DEPARTMENT CHANGES AND ACTIVITIES AT THE UNIVERSITY OF VIRGINIA

Few changes have been made this session in the teaching and research staff of the school of chemistry. DR. RICH-

MOND T. BELL, who received his Ph.D. degree from Virginia last year, is now instructor of inorganic chemistry. DR. EDWIN C. MARKHAM, formerly assistant professor of chemistry, has been appointed as a research associate in physical chemistry. DR. GUNTHER VON ELBA, a graduate of the University of Berlin, has joined the staff as research associate in physical chemistry.

DR. DOUGLAS G. HILL is continuing researches in the field of photochemistry under his appointment as research associate in physical chemistry. DR. LYNDON F. SMALL is directing the Drug Addiction Laboratory, organized last year under the auspices of the National Research Council, Division of Medical Sciences.

Record registrations in the University this fall will probably bring the total of those registered in chemical and chemical engineering courses well above 600 men.

The 1930 public lecture on chemistry under the auspices of Alpha Chi Sigma was given on November 6th by DR. HARRISON E. HOWE, editor, *Industrial and Engineering Chemistry*. "Chemistry in the Modern Competition" was the subject of a most illuminating description centering around the chemical contents of the now famous little brown bag which has revealed its secrets to audiences all over the United States. Casein plastics, hydrogenation, cellulose products, blue coal, silver ice, domestic tung oil, and acoustic bagasse filed out of the bag and across the long lecture table among scores of other chemical fabrications before the eyes of a capacity attendance. Alpha Kappa chapter yearly puts on this event as one of its several beneficial activities, and is to be congratulated on the choice this year of Dr. Howe of Alpha Beta Chapter at Michigan.

COLLOID LECTURES AT UNIVERSITY OF WISCONSIN

Science has reported that a series of lectures by DR. ROSS A. GORTNER, of the division of agricultural biochemistry, University of Minnesota, was scheduled at the University of Wisconsin from December 9th to 12th, under the auspices of the Wisconsin Alumni Research Foundation. The series included two general lectures on "The Application of Colloid Chemistry to Biological Problems" and "Biochemistry and the Problem of Organic Evolution," as well as lectures before specific groups on his own researches in the field of colloid chemistry and the application of physico-chemical methods to biology and medicine.

DR. HALE LECTURES IN INTERESTS OF AMERICAN CHEMISTRY

On October 16th, DR. HARRISON HALE, head of the department of chemistry of the University of Arkansas, spoke before the Arkansas Congress of Parents and Teachers in their convention at Jonesboro, Arkansas, on "Increasing the Joy of Living"; on November 5th at Fort Smith before the state meeting of the General Federation of Women's Clubs on "Chemistry and Citizenship"; on November 13th before the Science Club of Little Rock and on November 14th before the Chemistry Section of the Arkansas Education Association on "Recent Advances in Industrial Chemistry." In each of these addresses the Women's Club Study course on American chemistry, offered by the Division of Chemical Education of the American Chemical Society was brought to the attention of the audience. Dr. Hale is chairman of the division committee in charge of the course.

Educational Statesmen. I believe that by the right training of men, both as to the hands and the mind, we add to the wealth of the world. The far-reaching quality of the work that energetic educators are doing lifts them out of the ranks of mere schoolmasters and puts them on the level of constructive statesmen. They are the servants of democracy in a sense that no other public servants are.—WALTER HINES PAGE

Recent Books

General Chemistry. HORACE G. DEMING, Professor of Chemistry, University of Nebraska. Third edition, John Wiley & Sons, Inc., New York City, 1930. ix + 715 pp. 143 figs. 14 × 22 cm. $3.50.

Great improvement in the appeal made to the student's interest and in the method of presentation is apparent in the general chemistry texts today over those of twenty-five or thirty years ago. Deming's well-known book, the third edition of which appeared in August, 1930, illustrates this. According to the title page this is an "elementary survey emphasizing industrial applications of fundamental principles."

Frequent reference is made to commonplace matters with which the student is already familiar; the pictures of industrial processes are unusually good; the statistics used are recent and well arranged. The explanation of the meaning of scientific research (page 26) and the description of current research at the close of many chapters are most valuable. That "no inventor or patent attorney can afford to neglect suggestions likely to be contained in the periodic table" is interesting.

Atomic structure is not discussed until the book is half complete, as the author does not wish "to have students building models of the chlorine atom before they have learned to generate chlorine in the laboratory" (page vi). Acids, bases, and salts are discussed for twelve pages before the word ion is introduced, and a discussion of ions is delayed to a later chapter.

The reviewer would prefer more emphasis upon the persons who have made chemistry that which it is today. Many are mentioned, but no photographs are given. Some men are as interesting as a porcelain plant, for example. One wonders where physics should be placed in Figure 1 (page 3); whether the student might not get the impression from page 606 that radium is a light metal; if nickel forms more useful alloys than iron (page 64).

But these are very minor details, and the book shows unmistakable evidence of thought and care in the selection and presentation of material. It contains much more than the average student can learn in a year's course, which the author recognizes:

"The instructor should select what he can make interesting, vivid, and of service in teaching the student to reason chemically, and should be content to omit the rest. Too many teachers try to excavate the entire contents of a textbook by the steam-shovel method" (page vi).

In a word the reviewer considers the book worthy of the rank of "excellent."

HARRISON HALE

UNIVERSITY OF ARKANSAS
FAYETTEVILLE, ARKANSAS

Exercises in General Chemistry. HORACE G. DEMING, Professor of Chemistry, University of Nebraska, and SAUL B. ARENSON, Associate Professor of Inorganic Chemistry, University of Cincinnati. Third edition, John Wiley & Sons, Inc., New York City, 1930. xiv + 298 pp. 20 figs. 14 × 22 cm. $1.80.

This manual follows the order used in the third edition of Deming's "General Chemistry" to which constant and satisfactory reference is made.

The authors state its chief aims:

"1. To make the student familiar with a few representative types of matter.

"2. To reveal some of the general principles that govern the transformations of matter.

"3. To afford some experience with the experimental methods by which chemistry has won its advances" (page vii).

To reach these objectives 74 exercises covering 211 pages are given. This is followed by 77 pages on qualitative analysis. Exercises are adapted for a two-hour laboratory period with additional paragraphs for use if a longer time is available. Space is reserved in the text for the student's record of his work.

In each exercise references to the "General Chemistry," a general statement of the purpose of the experiment, list of materials and of apparatus, and directions are given. Then a series of questions with space for answers or a blank table for results follows. These questions are well chosen and cannot be satisfactorily answered unless the student really has done the work.

More special apparatus is required than is ordinarily used in a course in general chemistry, such as gas burets, apparatus for filtering hot liquids, and for filtering under diminished pressure. The hope is expressed "that the choice of exercises may not too often be determined by limitations in equipment" (page ix). There will be considerable opportunity for choice as all the work in the manual cannot be given in the time usually available.

The authors have achieved the aims set for themselves. The reviewer would question the advisability of giving twenty-one physical and chemical properties in the first laboratory exercise. Twenty of these are defined while after "transparency" the only statement is "glass and celluloid" (page 4). The cut of the pipet on Figure 5, page 21, is omitted. On page 40 it is stated "1 l. of oxygen, under the given conditions, weighs 1.42 deg."

But such mistakes are exceedingly rare and evidently the printer's. The authors have done their work with care. The physical make-up of the book is attractive and well done. Information of value concerning buffered solutions, indicators, solubility, vapor pressure, and density are given in the appendix. Even the inside of the covers is filled with helpful information.

Undoubtedly this third edition will prove useful and valuable as have the two earlier editions.

HARRISON HALE

UNIVERSITY OF ARKANSAS,
FAYETTEVILLE, ARKANSAS

College Chemistry Quiz Book for Kendall's Smith's College Chemistry. CECIL V. KING, PH.D., Assistant Professor, and WORTH WADE, PH.D., formerly Instructor, both of Washington Square College, New York University. The Century Co., New York City, 1930. viii + 209 pp. 13 × 20 cm. $1.50.

This book, one of the Century Chemistry Series, edited by Dr. James Kendall, was prepared for use with Kendall's revised edition (1929) of "Smith's College Chemistry." The questions and exercises follow the text which, as is well known, follows the established historico-systematic procedure. It begins with a few general topics. These are followed by oxygen, hydrogen, and other non-metallic elements, then by the metals. The usual chapters on hydrocarbons, etc., are also included in appropriate places. Appendix B is devoted to oxidation-reduction equations and Appendix C to a four-place logarithm table on pages which face each other. This last feature is a very desirable one as the student has to do with many problems.

The quality of paper, printing, and binding are excellent and the size is a convenient one.

Procedure employed for each chapter consists of one or more general statements, examples of problems, exercises, review questions, true and false statements, and statements to be completed by the students. For the last two items, space is provided with dotted lines. In addition, for the last item, the student is directed to rewrite the false statements making them true without changing the context.

The material is well selected and will be of much service to chemistry students of

college grade and to teachers, especially to the younger teachers of chemistry.

C. A. BRAUTLECHT

UNIVERSITY OF MAINE
ORONO, MAINE

Chemistry and Cookery. ANNIE LOUISE MACLEOD, Ph.D., Dean of the College of Home Economics, Syracuse University, and EDITH H. NASON, Ph.D., Professor of Foods, Syracuse University. First edition, McGraw-Hill Book Co., Inc., New York City, 1930. xii + 545 pp., 25 figs. 14 × 20.5 cm. $3.50.

The attempt to choose from the vast fund of chemical knowledge the principles most useful to the student of home economics is a problem of great interest as well as one which is attended with most serious difficulties. The authors of this text acknowledge the difficulties and forge ahead using a method of presentation based on the application of the theory of chemistry to home economics problems. From the standpoint of the foundation principles of education, the arrangement is sound. Though not mentioned as such, the principles of the "unit method" are carried out especially in certain sections of the book, a few of which are mentioned as follows: the study of carbon dioxide, carbonates, and baking powder in succeeding chapters; the development of organic chemistry with the following consecutive groups: esters, oils, fats, soaps; carbohydrates and flour; proteins and the cookery of eggs and meats. In these and other unit sections of the book, the interest of the pupil is kept on the purpose for which she learns the principles of chemistry and there is no better way to aid the memory than by using, in various ways, the principles learned.

The reviewer believes that certain parts of the first chapters could be extended to include more chemical applications, especially in the laboratory work. For example, a few quantitative experiments to show the combining relationships between elements and to show valence would seem to make more vivid the calculation of the weights of atoms and molecules as mentioned in Chapters II and III. By means of a few such determinations, it is possible to obtain a knowledge of the exactness of chemical changes and to lead students to think in terms of units of weight of the size of the hydrogen atom or of one-sixteenth the oxygen atom, which conception could nicely lead on to a discussion of the proton as a positive unit of matter.

As another example of the inclusion of more laboratory experiments, it seems probable that the study of a few more elements and compounds would make the student more familiar with the composition of matter and the simple changes in matter which go on around us. It would also give her a more satisfactory technic in handling difficult apparatus. It could be recommended that the preparation of two or more colloids of a chemical nature would nicely amplify the study of the general principles for making colloids mentioned on page 189. After such a study the application of these same methods to the preparation of certain foods, as mentioned on page 498, would be especially valuable.

Having in mind the aim of obtaining a foundation of chemistry which will be of value in later courses in home economics, it would seem that the book rather overemphasizes the application of chemistry in cookery processes at the expense of other phases of home economics work. It is most important that students who continue in many of the major lines of home economics have a course in elementary chemistry and in organic chemistry which will be a foundation for further chemistry courses to meet their advanced needs. The material of this text is uniquely planned for a very excellent course in chemistry and cookery. There is some question as to whether or not it would adequately meet the requirements of the general home economics student.

NELLIE M. NAYLOR

IOWA STATE COLLEGE
AMES, IOWA

Reactions and Symbols of Carbon Compounds. T. CLINTON TAYLOR, Ph.D., Associate Professor of Chemistry, Columbia University. First edition, The Century Co., New York City, 1930. x + 704 pp. 14 × 21 cm. $4.00.

Like the great American novel the great elementary textbook of organic chemistry has probably not been written. However, there have been several laudable efforts during the last few years to produce a work which would get away from the old orthodox and rather dull, unsystematic treatment of the subject. The present book is such an effort and, on the whole, as it seems to the reviewer, quite a successful one.

The extent and detail of this text is such that it should serve for a very complete one-year course and possibly, supplemented by reading assignments in more advanced books, for an additional half-year course. The author has attempted to develop the subject on the basis of experimental experience, and to bridge the gap, which undoubtedly exists in the minds of most of our students of elementary organic chemistry, between theory and practice. The author's desire is as he says "to help the student help himself by showing him how a set of experimental data may be interpreted in the light of current chemical concepts."

Undoubtedly, Professor Taylor has succeeded in what he has tried to do and the result is a sustained, logical treatment in which the symbols and equations possess a vitality and reality not commonly met with in elementary science texts. It should be repeated that the effort is sustained because all too frequently a writer starts out with a novel and often useful method of treatment which weakens and fades out after the first hundred pages or so. It is interesting to note that the interpretation of reactions by means of the electronic theory of valence has not been used to any extent and is not mentioned until Chapter VI. This seems to the reviewer to be a good thing because it has been his experience with elementary classes that the students have more difficulty in mastering the mechanism of the electronic theory than they do in learning the facts for which it is supposed to be a mnemonic. In connection with this the author erroneously has attributed the book "Valence" (Chemical Catalog Co., New York City) to W. K. Lewis, instead of to G. N. Lewis.

In the way of adverse criticism it may be said that some of the chapters lack "meat." An increase in the number of reactions and properties might have added to the usefulness of the work without lengthening it unduly. Another minor complaint of quite a different sort has to do with the author's tendency to use ionic reaction equations whenever an inorganic compound or element is involved. He speaks of adding non-ionic alcohol to ionic (implied) acid dichromate. While this has usually been done in the past, it is doubtful whether, in the light of present knowledge, it is wise to draw such a sharp distinction between the two classes of compounds.

On the whole Professor Taylor's effort is a valuable addition to our array of organic chemistry texts. Not the least of its merits is the excellent quality of the printing. Even the notes in small print can be read easily and without strain, and the formulas and equations are set down in an unusually clean-cut fashion.

GREGG DOUGHERTY
PRINCETON UNIVERSITY
PRINCETON, N. J.

Recent Advances in Physical and Inorganic Chemistry. ALFRED W. STEWART, D.Sc., Professor of Chemistry in the Queen's University of Belfast. Sixth edition, Longmans, Green & Co., New York City, 1930. xi + 387 pp. 32 figures, 5 half-tone plates. 21.5 × 14 cm. $7.00.

The sixth edition of this well-known work will not disappoint those who have read any of the earlier editions. The record of the works of pioneers is always interesting and as told by Doctor Stew-

art in "Recent Advances" is fascinating. Of importance to many in connection with recent work is the fact that the writer has "borne in mind that some . . . readers are not professed mathematicians." The essential mathematical treatment is present but in such form that all may read with interest and profit.

To make room for fresh material three chapters of the previous edition are omitted, but even so the later edition contains 75 additional pages. The old material has been brought up to date and several new chapters added dealing with line, emission band, and continuous emission spectra, the Donnan equilibrium, and flame reactions. The latest work on all the recently discovered elements is included. The subject of cosmic rays is carefully discussed.

To criticize an author's choice of what should appear in a work of this kind is easy but rather unfair. Things apparently important to one may not seem so to another. Perhaps the recent theories of the electron have, at present, slight bearing on chemistry and the mathematics of these theories is undeniably uninviting to many. Nevertheless, the reviewer believes the book would be improved if an elementary treatment of the subject were included. He also regrets that the discussion of Bonhoeffer's work on parahydrogen is not more extensive.

The excellence of "Recent Advances" is considerably enhanced by the very abundant footnotes and references. A good "Chart to Illustrate the Disintegration Series of the Radio-Elements" is included. This is a book every teacher and advanced student should own.

MALCOLM M. HARING
UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

Matter and Energy. An Introduction by Way of Chemistry and Physics to the Material Basis of Modern Civilization. GERALD WENDT, formerly Dean, and OSCAR F. SMITH, Assistant Dean, School of Chemistry and Physics, The Pennsylvania State College. First edition, Volume 1, P. Blakiston's Son & Co., Inc., Philadelphia, 1930. xiv + 335 pp. 64 illustrations. 19.25 × 13.25 cm. $1.50.

This book contains the material covered in the introductory course combining chemistry and physics given at the Pennsylvania State College. All students in the School of Liberal Arts and the School of Education are required to take this course.

No distinction is made between chemistry and physics but basic material is selected to illustrate the fundamental aspects of energy and matter. The book is intended to stimulate thinking and relieve the student from taking lecture notes upon the subject matter. The text introduces general or topical questions in each chapter and is to be used as reference material to aid in the discussion of experiments. The experiments are presented by the demonstration-discussion method. Each chapter ends with assignments and suggestions for outside reading. A list of questions stimulates thought and serves to fix the material by requiring original and independent work by the student. In the words of the authors "this first volume is an inquiry on the nature of matter and of energy. Its plan is to lead the student by the most direct path to the fundamental concepts—molecules, atoms, protons, electrons, and radiation and thus to a structural picture of the basic components of the universe." A second volume will soon be published and will discuss the practical application of these fundamental concepts.

A survey of the material is best indicated by the chapter headings.

Chapter I.	A Question of Value;
Chapter II.	A Question of Importance;
Chapter III.	A Question of Perspective;
Chapter IV.	Things in General;
Chapter V.	Material Differences;
Chapter VI.	Solidity and Dispersion;

Chapter VII.	The Effect of Temperature;
Chapter VIII.	Transformations of Matter;
Chapter IX.	Pressure in Chaos;
Chapter X.	Molecules in Motion;
Chapter XI.	Energy in Waves;
Chapter XII.	Electrons;
Chapter XIII.	Positive Rays;
Chapter XIV.	X-Rays;
Chapter XV.	Radium;
Chapter XVI.	Within the Atom;
Chapter XVII.	The Foundation of Chemistry;
Chapter XVIII.	What Next?

In the last few years teachers of chemistry have heard a great deal about the subject presented for its cultural value rather than for technical training. In fact the first text written for students of pandemic chemistry has just been published. "Matter and Energy" has extended the field to cover physics, thus once again emphasizing the rapid disappearance of the boundary line between the two sciences. If a student is to have no other training in these subjects a study of this text will aid him in gaining some comprehension of the modern physical sciences. One wonders however just how much can be accomplished by references to college texts of physics and chemistry without the necessary technical background.

The book is well written, the illustrations are excellent, and the publishers have used good paper and provided a suitable binding. Teachers of chemistry will find this book an interesting addition to the reference shelf, not only because of its contents but also as an example of a novel experiment in liberal education.

R. N. MAXSON

UNIVERSITY OF KENTUCKY
LEXINGTON, KY.

Optical Activity and High Temperature Measurements. F. M. JAEGER, University of Groningen, George Fisher Baker Non-Resident Lecturer at Cornell University, 1928–29. McGraw-Hill Book Co., Inc., New York City, 1930. xi + 450 pp. 137 figures. 15 × 23 cm. $4.00.

This reasonably priced book, considering its size, makes available to a wider audience a series of scholarly lectures delivered by Professor Jaeger at Cornell University during the second semester of 1928–29 under the George Fisher Baker Non-Resident Lectureship in Chemistry. The introductory lecture, 19 pages, is a general discussion of "The Present and Future State of Our Natural Resources." The other lectures are devoted to asymmetry and optical activity, high-temperature precision measurements, and the structure of ultramarine, three fields of research in which Professor Jaeger is an outstanding authority.

In the first section, "Spatial Arrangement of Atomic Systems and Optical Activity," 212 pages, the complex salts are given special attention. The following subjects are discussed: elements of symmetrical figures; Pasteur's law, asymmetric atoms; non-superposable symmetry; symmetry and resolvability of complex salts; structure of inorganic complexes; measurement of optical rotation; various types of complex salts (six lectures); asymmetrical photosynthesis; circular dichroism. The second section, "Methods, Results, and Problems of Precise Measurements at High Temperatures," 167 pages, is composed of the following chapters: fundamental principles and problems; surface tension; specific gravity and viscosity; electrical conductivity; internal friction; specific heat. The concluding chapter, 39 pages, is on "The Constitution and Structure of Ultramarine."

These lectures are a striking example of the value of visiting lectureships in bringing to us authoritative first-hand accounts of research in other laboratories, especially in Europe. This statement applies particularly to Professor Jaeger's discussion of the optical properties of complex salts, a field that has never received much attention in this country, as is shown, for example, by the dearth of references to

American literature in this section of the book. It is interesting to recall in this connection that the first resolution of an inorganic complex salt was carried out by an American student working in Werner's laboratory.

Cornell's department of chemistry is to be congratulated on its choice of a lecturer and to be thanked for sharing the benefits of its Baker Lectureship with other chemists. Professor Jaeger could not have left a more valuable souvenir of his visit to this country.

LAWRENCE W. BASS
MELLON INSTITUTE OF INDUSTRIAL RESEARCH
PITTSBURGH, PA.

Einführung in Die Mathematik Für Biologen und Chemiker. LEONOR MICHAELIS, University of Berlin. Julius Springer, Berlin, 1927. vi + 313 pp. 116 figs. 14 × 22 cm. Rm. 16.50; bound, Rm. 18.00.

The author introduces the subject by a brief review of a few theorems of geometry and algebra; the trigonometric functions are mentioned and series are defined. The second chapter covers the field of analytical geometry and the graphic representation of the usual analytical and transcendental functions. In the next two chapters the author presents the concepts of the differential and integral calculus in the usual fashion as found in any of the numerous books on the subject. However, the attempt is made to connect the subject matter of mathematics with the fields of chemistry and biology by presenting and solving problems taken from these sciences. It is felt that these problems are not sufficiently numerous. Every one should be in complete agreement with the author's idea that students of chemistry and biology should be trained most thoroughly in certain branches of mathematics. The best way no doubt to teach the use of mathematics lies in its application to actual problems. It is hoped that the author will be later able to enrich his volume by many more examples taken from the field of science that he is interested in. The fifth chapter covers the theorems of Taylor and MacLaurin regarding series. Fourier series are mentioned. A necessarily brief discussion of differential equations is presented in the sixth chapter. The addition of a chapter (Chapter 8) on the theory of errors is of course quite in order in a book meant to be used by experimental scientists. The treatment seems adequate for an introduction to the subject. Again it is felt that this interesting volume can be made even more useful by the inclusion of many more problems.

S. C. LIND
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINN.

The Metallurgists and Chemists' Handbook. Compiled by DONALD M. LIDDELL, Member of Weld & Liddell, economists and engineers; member M.M. S.A., A.I.M.E., Inst. of Metals (Brit.). pp. 10.5 × 17.25 cm. $5.00. Third edition, McGraw-Hill Book Co., Inc., New York City, 1930. vii + 847 pp. 10.5 × 17.25 cm. $5.00.

The third edition of this excellent handbook, although enlarged by one-third over the 1918 edition, still fulfils its purpose of supplying to the metallurgist and chemist the most necessary physical and chemical tables in a form so compact that it may be carried by the traveler or prospector without undue weight added to his kit.

In addition to a complete index the book is divided into twelve sections: Mathematics; Price and Production Statistics; Physical Constants; Chemical Data; Sampling, Assaying, and Analysis; Ore Dressing; Cyanidation; Fuels and Refractories; Mechanical Engineering and Construction; General Metallurgy; Organic Chemistry; First Aid.

The mathematical section covering fifty pages includes tables of weights and measures and money both U. S. and foreign, fundamental equations in algebra, trigonometry, geometry, and calculus, various tables of interest, squares, cubes, etc., and the usual trigonometric tables. Metallurgical price and production sta-

tistics is most complete, the monthly prices of the most common metals covering periods of twenty years and production throughout the world for five years. Physical constants of the inorganic compounds is rather brief, about 500 elements and compounds being included instead of 3000 to be found in a typical chemical handbook. "Chemical Data," a section of 90 pages, deals with the structure of the atom, the properties of the common elements, qualitative analysis of the metals and acids, and tables of chemical properties. Following this the essentials of sampling, fire-assaying, and metallography are covered as is the quantitative determination of the common elements in table form. Ore dressing is quite complete with quantities of data on the practice of crushing, screening, concentrating, thickening. and flotation. A brief description of the theory and practice of cyaniding follows with considerable operating data. "Fuels and Refractories," primarily of interest to the furnace man, describes the properties of the major fuels and refractories used in metallurgical and chemical operations. Mechanical engineering data on construction is included with tables concerning the handling of solids, liquids, and gases. The largest section of the book is devoted to general metallurgy. The constitution of about 1300 alloys is given and various data on reduction and refining of the common metals, properties of slags, mattes, etc. In the final section a few pages are given to the physical and chemical constants of the more common organic compounds, followed by instructions in first-aid treatment.

The physical data of the chemical compounds, both organic and inorganic, are so brief that from the chemical point of view the book will not appeal to the chemist because of the more extensive handbooks available. For the metallurgist the chemical tables are quite sufficient. Written from the metallurgist's point of view this volume, containing a most complete accumulation of facts of metallurgical physics and chemistry in table form, will be of inestimable value to the man primarily a chemist and secondarily a metallurgist.

CROSLEY F. BAKER
PEARSON MEMORIAL LABORATORY
TUFTS COLLEGE, MASS.

MISCELLANEOUS PUBLICATIONS

Doctorates Conferred in the Sciences by American Universities, 1929-30. Compiled by CALLIE HULL and CLARENCE J. WEST. Reprint and Circular Series of the National Research Council, No. 95. National Research Council, Washington, D. C., 1930. 49 pp. 17 × 25 cm. $0.50.

Victor Directory of Film Sources. Victor Animatograph Corporation, Davenport, Iowa, Second edition, Dec., 1930. 48 pp. 14 × 19.5 cm. Gratis.

The purpose and scope of this volume is adequately described in the foreword herewith quoted:

"Although the need has long existed, this is believed to be the first attempt ever made to provide a complete, accurate listing of all known sources of 16-mm. films exclusively. 35-mm. (professional standard) films are not listed in this directory as it is intended only for the benefit of users of 16-mm. motion picture projectors.

"The Directory is being published entirely at the expense of the Victor Animatograph Corporation. No charge has been made for the listings, and distribution is free to owners and prospective owners of 16-mm. equipments. The information contained herein may be accepted as being strictly impartial, as the Victor organization does not produce or distribute films of any kind, and is not financially interested in any producing or distributing companies.

"The Directory should prove highly accurate as great care has been exercised in its compilation. The first edition, which was published in May, 1930, contained surprisingly few errors. This, The First Revised Edition, has been so carefully

corrected and appended that it is believed to be the most authentic and accurate film listing in existence.

"The Directory will be kept constantly up to date, and further revised editions will be issued as often as necessary. Copies of the revised editions will be sent only to those requesting that their names be kept permanently on the Directory Mailing List.

"The tremendous demand for the first edition, the hundreds of commendatory letters that have been received praising the achievement, and the lack of even a single criticism of the construction of the Directory would seem to indicate that we 'builded better than we knew.' No effort or expense will be spared in making future editions equally as useful and as worthy of praise."

Publications of the Bureau of Educational Research. *University of Illinois Bulletin*, XXVIII, No. 21 (Jan. 20, 1931). A list of bulletins and circulars issued by the Bureau of Educational Research of the University of Illinois. Single copies may be had on request. Address Walter S. Monroe, Director, Bureau of Educational Research, University of Illinois, Urbana, Ill.

Record of Current Educational Publications. Comprising publications received by the Office of Education, January–March, 1930. Compiled by MARTHA R. MCCABE, Acting Chief, Library Division. U. S. Dept. of the Interior, Bulletin, 1930, No. 15. U. S. Government Printing Office, Washington, D. C. (For sale by the Superintendent of Documents, Washington, D. C.) 46 pp. 15 × 23 cm. $0.10.

Publications Available September, 1930. U. S. Dept. of the Interior, Office of Education, Washington, D. C. U. S. Government Printing Office, Washington, D. C., 1930. 29 pp. 15 × 23 cm. Gratis.

New Anesthetic, Avertin or Tribromethanol, Used in Eye Surgery. Successful use of the new anesthetic, avertin, in certain kinds of eye operations is reported by Dr. W. H. Wilmer of the Johns Hopkins Hospital and University in a communication to the American Ophthalmological Society. Avertin is known chemically as tribromethanol. It was developed in Germany by Dr. Richard Willstätter of Münich and Dr. Duisberg of Jena.

The new anesthetic has many advantages over ether and is equally safe for certain types of surgery. It is injected instead of being inhaled and is given while the patient is in his bed. He quickly falls into a deep sleep and awakens hours after the operation. The preliminary period of excitement and nervousness is eliminated, as well as a good bit of the post-operative pain and discomfort. Vomiting is infrequent after awakening from avertin anesthesia.

From the surgeon's viewpoint avertin has the added advantage of giving thorough relaxation and there is less bleeding. Pulse and breathing rate are only slightly changed and the blood pressure is lowered a little.

"Where general anesthesia is required, avertin is a safe and valuable addition to the list of drugs used in ophthalmic surgery," Dr. Wilmer said. He pointed out that avertin cannot be used safely where the patients are aged or very weak or when certain diseases are present.

The preparation and administration of the drug require the attention of a member of the hospital staff, either doctor or competent anesthetist, who must give most of his time to this duty.—*Science Service*